OPERATION AND MAINTENANCE

ACQUISITION SYSTEM CAPE CANAVERAL

project

mercury

prepared for NASA

MS-110

project
mercury

OPERATION AND MAINTENANCE

ACQUISITION SYSTEM
CAPE CANAVERAL

prepared for
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WARNING

The equipment described in this manual employs voltages which are dangerous. Use appropriate caution when working on this equipment.

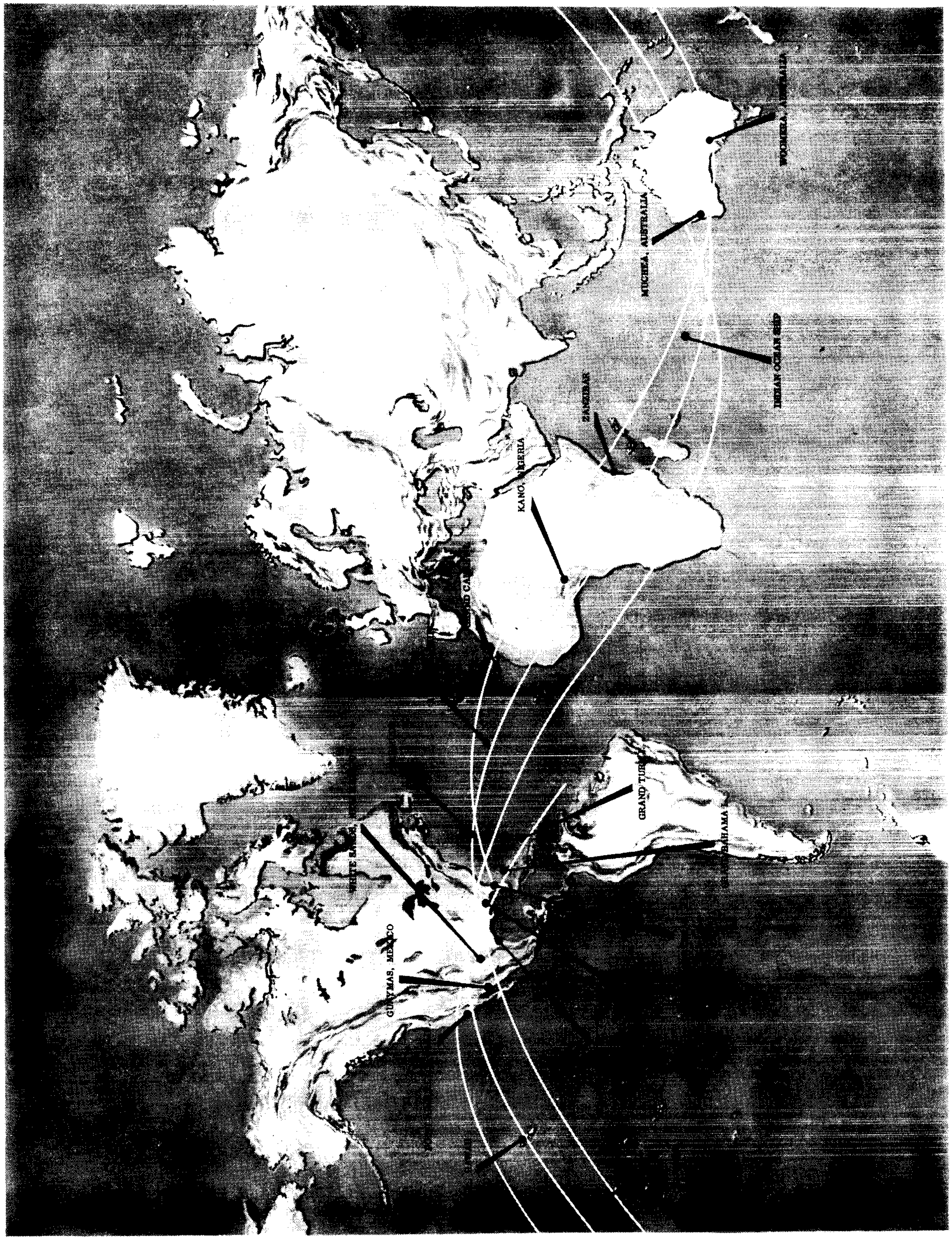


Figure 1-1. Locations of Project Mercury Sites

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL INFORMATION

A. SCOPE OF MANUAL

This publication comprises operating and maintenance instructions for the Acquisition System which forms a part of the Mercury ground instrumentation at the Cape Canaveral site. The Grand Bahama Island and Grand Turk Island sites, also part of the Cape Canaveral complex, are covered in a separate acquisition system manual, MS-111.

B. PROJECT MERCURY SCOPE

(1). The prime objective of Project Mercury is manned orbital flight with a safe return of the man from orbit. The manned vehicle or satellite that is placed into orbit is called the capsule, and the individual making the orbital flight is called the astronaut.

(2). A launch vehicle with a radio-inertial guidance system will be used to place the capsule into orbit. The launch will be from Cape Canaveral, Florida with launch azimuth slightly north of east (inclined 32.5 degrees to the equator) and nominal orbit insertion point approximately 410 nautical miles from Cape Canaveral. The planned orbit will have a period of 88 minutes and will be at an altitude of 105 ±5 nautical miles.

(3). Initially, the orbital flights will each consist of three orbital cycles with a water landing west of Puerto Rico. In the event of an in-flight emergency, back-up systems are provided in the capsule to permit the flight to continue until the next passage over the eastern United States. Emergency landings at the completion of one orbit can be made in the Atlantic off of Charleston, South Carolina or near Bermuda. At the end of the second passage, the emergency landing area is in the Atlantic off of Charleston, South Carolina. If a malfunction occurs during the early launch phase, emergency procedures will permit a water landing off of Cape Canaveral. Controlled retro-firing will be used to contain most of the abort impact areas near Bermuda or in the vicinity of the Canary Islands.

(4). To implement Project Mercury, a world-wide network of 18 ground-based tracking and instrumentation sites has been established together with a control center and a computing and communications center. Eleven of these sites are equipped with long range tracking radars; these compose the tracking network. Sixteen sites have telemetry receiving and display equipment. Six of the sites are equipped to transmit command control signals to the capsule; these are known as command sites. Sixteen of the sites are equipped with capsule communications equipment that provides two-way voice contact with the astronaut. In addition, all of the sites are linked with the computing and control centers by a ground communications network. See figure 1-1 for the locations of the sites.

C. SITE FUNCTIONS

From orbit insertion until landing, the tracking and ground instrumentation systems will provide continuous prediction of the capsule location; they will monitor the status of the capsule and astronaut; and they will permit the command functions necessary for the mission. The functions of the tracking and ground instrumentation systems are completed when the capsule has landed and the best possible information on the landing point location has been supplied to a recovery team. Table 1-I lists the various sites and the functions of each.

D. SYSTEM FUNCTION

The function of the acquisition system is to supply pointing data (capsule azimuth and elevation) to radars, the Mercury Control Center TLM-18, and the voice and command transmitting antenna. Pointing data is made available to the automatic-tracking radars and TLM-18 for initial acquisition of the capsule and to aid in quick re-acquisition if capsule tracking is lost during a pass over the site. The transmitters have no automatic tracking function and the voice and command transmitting antenna normally is pointed at all times during a pass by data from the acquisition system.

1-2. EQUIPMENT SUPPLIED

Table 1-II lists the equipment supplied for the acquisition system. Both contractor and government-furnished equipment (GFE) are listed. The HF antenna positioning system, listed in table 1-II, is not functionally part of the acquisition system. However, part of it is on the acquisition data console, and to that extent it is covered in this manual.

TABLE 1-I. FUNCTIONS OF EACH SITE

Site	S-Band Radar Tracking	C-Band Radar Tracking	Telemetry & Capsule Communications	Command Control
Cape Canaveral, Florida	X	X	X	X
Grand Bahama Island	—	—	X	—
Grand Turk Island	—	—	X	—
Bermuda	X	X	X	X
Atlantic Ship	—	—	X	—
Grand Canary Island	X	—	X	—
Kano, Nigeria	—	—	X	—
Zanzibar	—	—	X	—
Indian Ocean Ship	—	—	X	—
Muchea, Australia	X	—	X	X
Woomera, Australia	—	X	X	—
Canton Island	—	—	X	—
Kauai Island, Hawaii	X	X	X	X
Point Arguello, California	X	X	X	X
Guaymas, Mexico	X	—	X	X
White Sands, New Mexico	—	X	—	—
Corpus Christi, Texas	X	—	X	—
Eglin, Florida	X	X	—	—

1-3. DESCRIPTION OF ACQUISITION SYSTEM

A. GENERAL

The acquisition system consists of an acquisition data console, a synchro remoting system, a synchro line amplifier, an 18-64 synchro speed converter, and a TLM-18 system. Each of these units and systems is described in the following paragraphs.

B. PHYSICAL DESCRIPTION

(1). ACQUISITION DATA CONSOLE (Figure 1-2)

The acquisition data console consists primarily of a rack, 59-5/8 inches high, 23-9/16 inches wide, and 22 inches deep, on which are mounted several

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT				
Acquisition Data Console	The Bendix Corporation Bendix Radio Division	R651498-1	1	MS-110, Acquisition System Manual—Operation and Maintenance — Cape Canaveral, Florida.
Synchro Remoting System, consisting of:	The Bendix Corporation Bendix Pacific Division	—	—	ME-412, Instruction Manual for Digital Synchro Data Transmission System
Transmitter-Receiver		1061778	1	
Transmitter-Receiver		1062383	1	
Two-Channel Receiver		1062384	1	
18-64 Synchro Speed Converter	Canoga Electronics Corporation	8489	1	ME-133, Handbook of Instructions for 18-64 Synchro Speed Converter.
TLM-18 System	GFE	TLM-18	1	AF-08(606)-1273 Handbook of Instructions, Automatic-Tracking Telemetry Antenna System.
TLM-18 Acquisition Bus Display Panel	The Bendix Corporation Bendix Radio Division	L653979-1	1	MS-110, Acquisition System Manual—Operation and Maintenance — Cape Canaveral, Florida.
HF Antenna Positioning System	Telrex Laboratories	397 RIS	2	ME-235, Instruction Manual for Telrex Rotator
Synchro Line Amplifier	Milgo Electronic Corporation	1007-10B	1	ME-132, Instruction Manual, Synchro Line Amplifier
TEST EQUIPMENT				
Oscilloscope	Hewlett-Packard Company	130B	1	ME-200, Operating and Servicing Manual, Model 130B/BR Oscilloscope.
Oscilloscope	Tektronix, Incorporated	545A	1	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode-Ray Oscilloscopes.

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Dual-Trace Calibrated Preamp	Tektronix, Incorporated	Type CA	1	ME-203, Instruction Manual, Type CA Plug-In Unit
Plug-In Preamplifier	Tektronix, Incorporated	Type L	1	ME-136, Instruction Manual, Type L Plug-In Unit
Viewing Hood	Tektronix, Incorporated	H510	1	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode-Ray Oscilloscopes (Accessories Section)
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio P/N A683940-1)	1	—
Unit Regulated Power Supply	General Radio Company	1201-B	1	ME-211, Operating Instructions, Type 1201-B Unit Regulated Power Supply
Regulated Power Supply	Lambda Electronics Corporation	71	1	ME-138, Instruction Manual, Lambda Regulated Power Supply Model 71
DC Power Supply	John Fluke Manufacturing Company, Inc.	407	1	ME-231, Instruction Manual, Model 407 DC Power Supply
Square Wave Generator	Tektronix, Incorporated	Type 105	1	ME-230, Instruction Manual, Square Wave Generator Type 105
Signal Generator	Boonton Radio Corporation	225-A	1	ME-188, Instruction Manual, Signal Generator Type 225-A
HF Signal Generator	Hewlett-Packard Company	606-A	1	ME-189, Operating and Servicing Manual
Transfer Oscillator	Hewlett-Packard Company	540-B	1	ME-232, Operating and Servicing Manual

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Wide Range Oscillator	Hewlett-Packard Company	200 CD	2	ME-198, Operating and Servicing Manual
Unit Oscillator	General Radio Company	1209-BL	1	ME-212, Operating Instructions, Types 1209-B and BL Unit Oscillators
Universal EPUT and Timer	Beckman Instruments, Incorporated	7370	1	ME-196, Instruction Manual, Model 7370 Universal EPUT and Timer
Frequency Converter	Beckman Instruments, Incorporated	7570 through 7573	1	ME-197, Instruction Manual, Model 7570 Series Frequency Conversion Equipment
Power Output Meter	The Daven Company	OP-962	1	ME-154, Instruction Manual
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Inc.	801	1	ME-118, Instruction Manual, Model 801 Potentiometric DC Voltmeter
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	2	ME-190, Operating and Servicing Manual
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	2	ME-191, Operating and Servicing Manual, 400D/H/L Vacuum Tube Voltmeter
Volt-Ohm-Milliammeter	Triplett Electrical Instrument Company	630-PL	3	ME-193, Instruction Manual, Model 630-PL Volt-Ohm-Milliammeter
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	1	ME-194, Operating and Servicing Manual, 330B/C/D Noise and Distortion Analyzer
RF Detector	Telonic Industries, Incorporated	XD-3	1	ME-135, Instruction Manual
Tube Analyzer	Triplett Electrical Instrument Company	3444	1	ME-199, Instruction Manual, Model 3444 Tube Analyzer

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Variac	General Radio Company	W10MT	1	ME-246, Operating Instructions, W10 Variac
Attenuator Pad	Telonic Industries, Incorporated	TGC-50	2	—
Miscellaneous Cables and Accessories	—	—	—	—

panels. A writing surface extends 18-1/2 inches from the front of the rack. Omitting blanks and starting from the top, the panels on the console are an intercom panel, an acquisition data panel, a synchro line amplifier, and a dual power supply. A relay chassis is mounted inside the console on the right side adjacent to the acquisition data panel. On the top of the console there are two HF antenna indicator units. The intercom equipment on the intercom panel is not functionally a part of the acquisition data console. For information on the intercom equipment, refer to the Intrasite PBX and Intercom System Manual, MS-109. For a description of the synchro line amplifier and HF antenna positioning equipment, refer to paragraphs 1-3. B. (2). and (6).

(a). ACQUISITION DATA PANEL

The acquisition data panel is made up of displays, indicators and controls.

1. Across the top of the panel there are four pairs of synchro receivers which display azimuth and elevation data from the TLM-18, CADDAC, voice and command transmitting antenna, and acquisition bus. At the center of the top there are two lamps ("CABLE WRAP") which indicate the azimuth position of the voice and command transmitting antenna relative to its limits of cable wrap.

2. Just below the synchro receivers there is a row of indicator and switch assemblies, henceforth called simply indicators and switches. The indicators consist of a set of lamps, color filters over the lamps, and a white, translucent screen on the front of the assembly. The switches are like the indicators with the addition of a multi-pole switch and a coil which, when energized, holds the switch contacts in their actuated position. The switch is initially actuated by depressing the screen. The screens of both the indicators and switches always appear white when the lamps are not lit. When the lamps are lit, the screens appear red, yellow, or green depending on the color of the filters in the particular assembly.

3. On the left, below the TLM-18 synchro receivers, are two indicators and one switch. The indicators are labeled "VALID

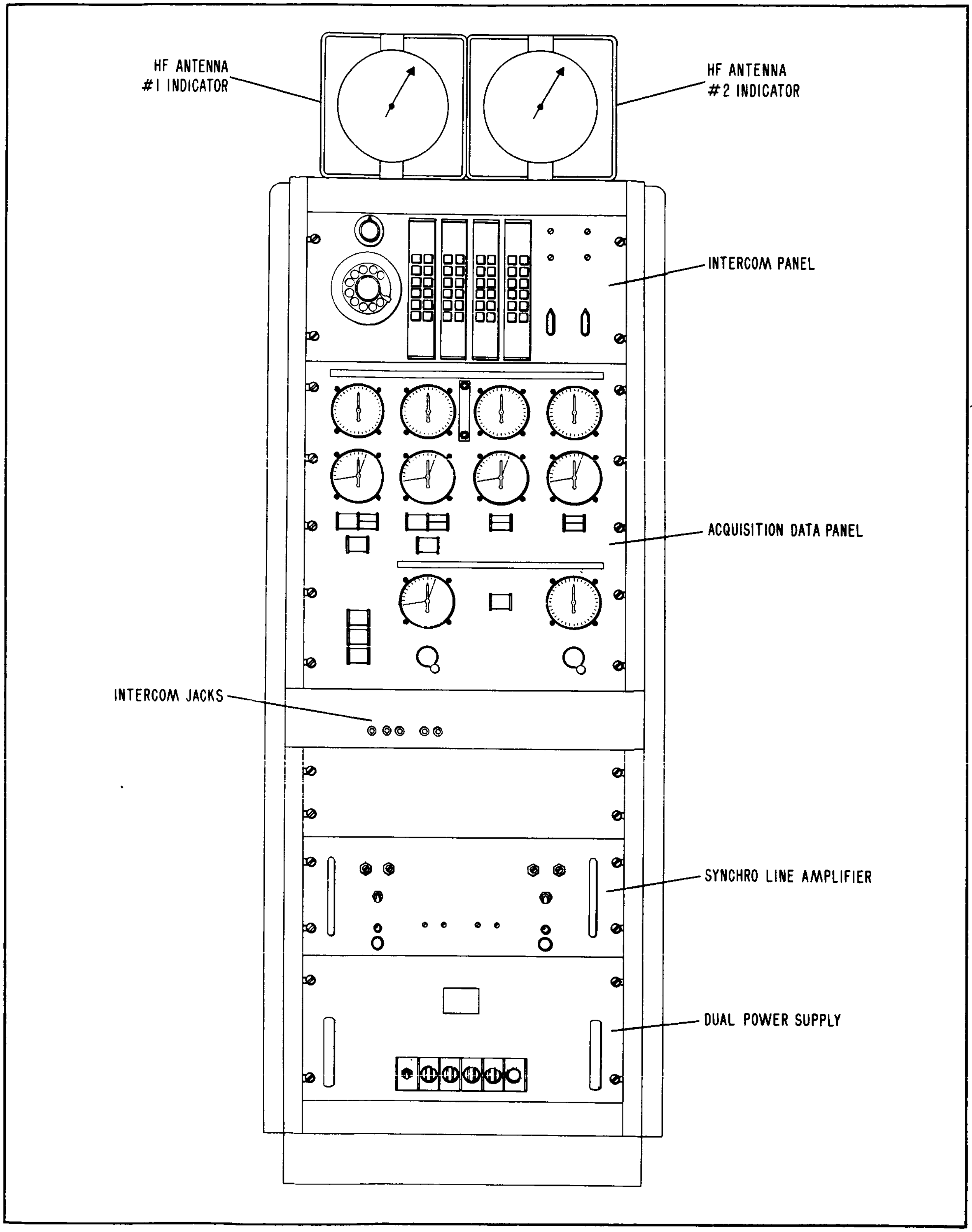


Figure 1-2. Acquisition Data Console

TRACK" (yellow when lit) and "MANUAL" (green when lit). The switch is labeled "SOURCE" (yellow when lit).

4. Two more indicators and a switch are below the CADDAC synchro receivers. One of the indicators is labeled "VALID TRACK" (yellow when lit). The other is a double indicator; the top half is labeled "SLAVED" (green when lit) and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

5. Beneath the voice and command transmitting antenna synchro receivers there is one double indicator. The top half is labeled "SLAVED" (green when lit) and the bottom half is labeled "MANUAL" (red when lit).

6. Beneath the acquisition bus synchro receivers is an indicator labeled "NO DATA ON BUS" (red when lit).

7. In the lower left-hand corner of the panel there is one indicator and two switches. The indicator is labeled "DATA LINK POWER" and is green when lit. Both of the switches are labeled "28V SUPPLY" and are either red or green when lit.

8. In the bottom center and bottom right-hand corner of the panel there is a pair of synchro transmitter-synchro receiver combinations, one for manual elevation settings and one for manual azimuth settings. The synchro transmitters are turned by handwheels on the front of the panel; the synchro receivers indicate the angular position of the transmitter rotors. Between the two receivers there is a switch labeled "SOURCE" (yellow when lit).

(b). <u>DUAL POWER SUPPLY.</u>

Four power supply chassis together with the relay chassis described below make up two, 28 VDC power supplies. Each power supply has a transformer, a silicon bridge rectifier, a fuse, and two filter capacitors on one chassis, and a filter choke and three filter capacitors on a second chassis. The dual power supply panel provides mounting for these four chassis. On the front of the panel are an off-on switch, which controls the primary power to both power supplies; a power-on indicator; and four line fuses — two for each power supply — in indicating type fuse holders.

(c). RELAY CHASSIS

The relay chassis provides mounting for two relays and two zener diodes which make up control circuitry for the 28 VDC power supplies. It also provides mounting for three relays which, when energized, connect acquisition data from various sources to the acquisition bus.

(2). SYNCHRO LINE AMPLIFIER

The synchro line amplifier, mounted on a 7-inch by 19-inch panel on the acquisition data console, consists of two pairs of amplifier units. Each pair of amplifier units makes up an amplifier channel; thus, the synchro line amplifier has two channels, one for azimuth information and the other for elevation information. On the front of the panel there are two identical sets of controls. Each set consists of two line compensation controls, an off-on switch, a power-on indicator lamp, and a fuse. On the back of the panel there are two individual chassis, each of which contains two amplifier units (one amplifier channel) and a power supply. For a complete physical description of the synchro amplifier, refer to the applicable equipment manual.

(3). SYNCHRO REMOTING SYSTEM (Figures 1-3 and 1-4)

The synchro remoting system consists of three units; two virtually identical transmitter-receivers (figure 1-3) and a two-channel receiver (figure 1-4). All three of the units are housed in cabinets 68-3/8 inches high, 23-9/16 inches wide, and 23 inches deep. The transmitter-receiver units consist of two transmitter channels and two receiver channels each: one transmitter and one receiver channel for azimuth information and one transmitter and one receiver channel for elevation information. The two-channel receiver unit has two receiving channels, one for azimuth and one for elevation information, which are essentially the same as the receiving channels in the transmitter-receiver units. The two-channel receiver unit also provides mounting space for the 18-64 synchro speed converter, which is not functionally a part of the receiver. (Refer to paragraph 1-3. B. (4).) For a complete physical description of the synchro remoting system, refer to the applicable equipment manual.

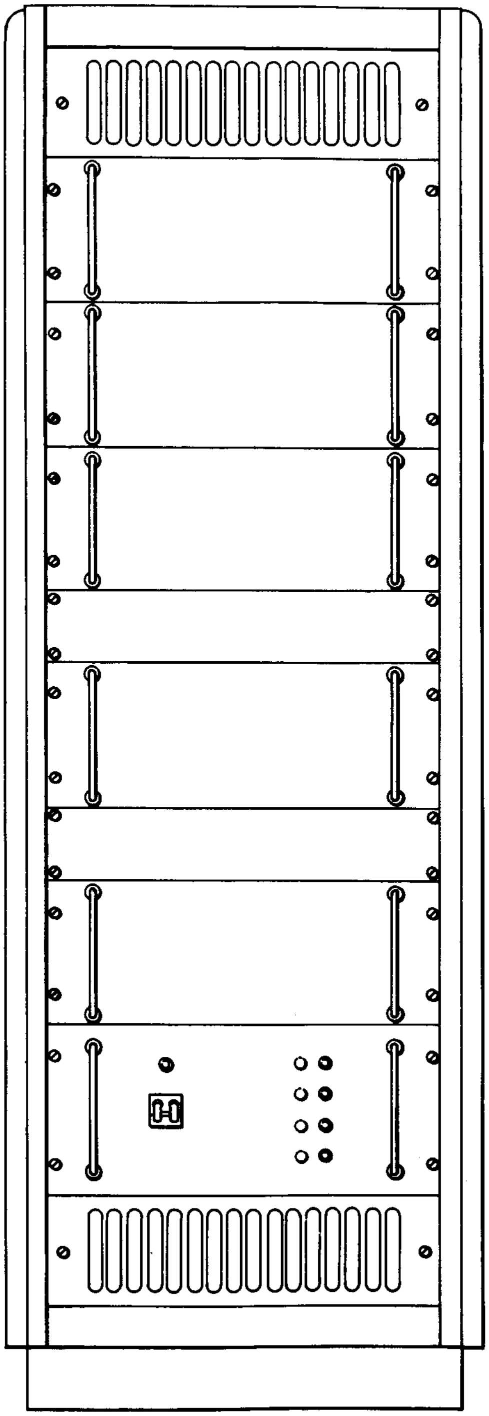


Figure 1-3. Synchro Remoting System Transmitter-Receiver

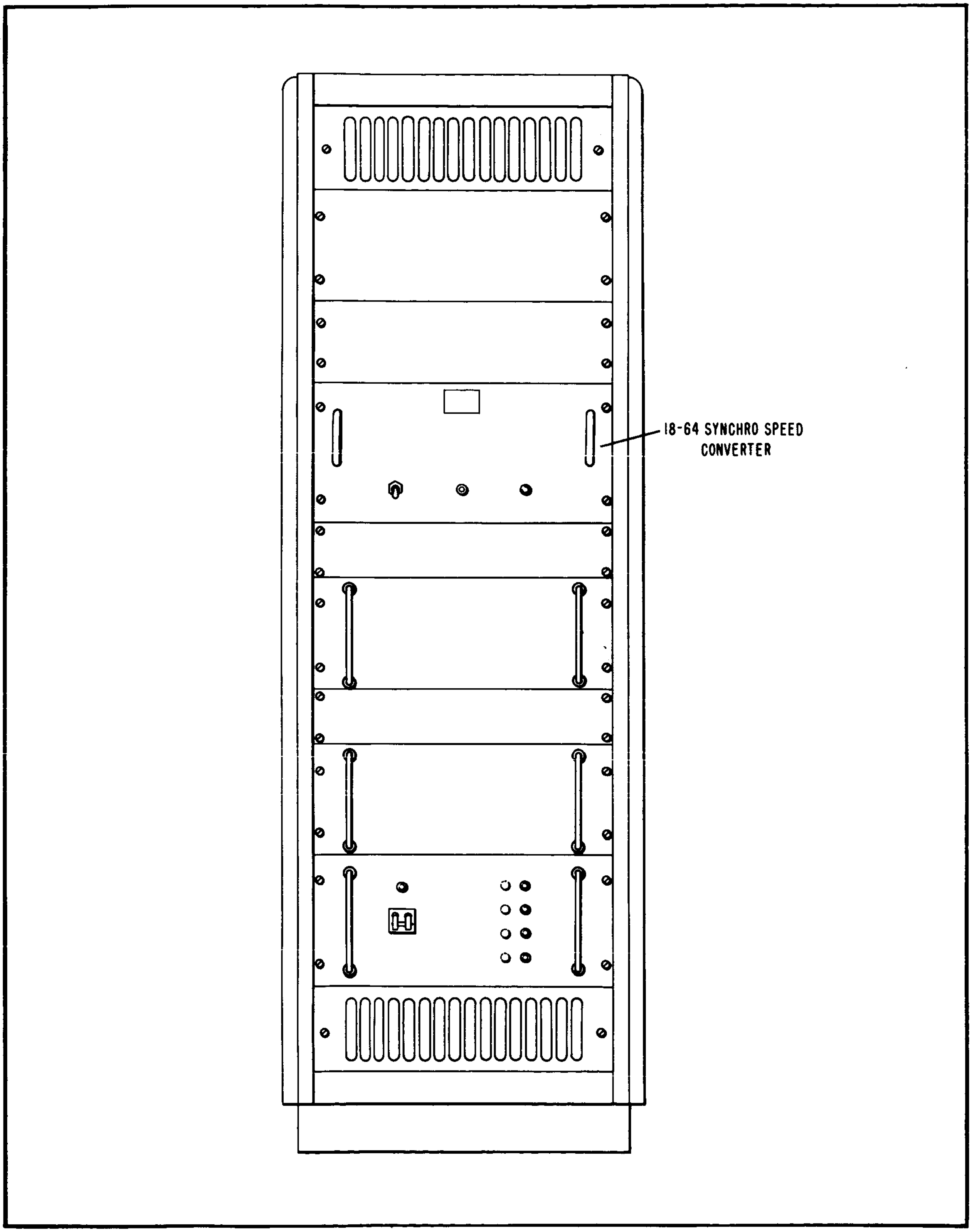


Figure 1-4. Synchro Remoting System Two-channel Receiver with 18-64 Synchro Speed Converter

(4). 18-64 SYNCHRO SPEED CONVERTER (Figure 1-4)

The 18-64 synchro speed converter is mounted on a panel in the two-channel receiver unit of the synchro remoting system. It is made up of a power supply, a control transformer, a servo amplifier, a motor and gear train, and a synchro transmitter. Refer to the applicable equipment manual for a complete description.

(5). TLM-18

The TLM-18 is government furnished equipment which has been modified by the addition of two synchro receivers mounted on the acquisition bus display panel and four synchro transmitters. For a physical description of the TLM-18, refer to the applicable equipment manual.

(6). HF ANTENNA POSITIONING SYSTEMS

Each of the two HF antenna positioning systems comprises a rotator unit, an indicator unit, and a control switch. The rotator units, mounted on the antenna masts, consist primarily of a drive motor and gearing and a synchro transmitter. The indicator units, mounted on the acquisition data console, consist primarily of a synchro receiver and a synchro reference transformer. The control switches are mounted on the intercom panel on the acquisition data console. (See figure 3-4.)

C. FUNCTIONAL DESCRIPTION

(1). GENERAL

The function of the acquisition system is to supply the best data available on the azimuth and elevation of the capsule to steerable antennas on the site. Figure 1-5 illustrates this function. When no actual tracking information is available, predicted azimuth and elevation of the capsule at a given time are put onto the acquisition bus by the setting of synchro transmitters on the acquisition data console. The setting of these synchro transmitters is the manual input shown on figure 1-5. The information manually set in at the acquisition data console is then available to the TLM-18, the voice and command transmitting antenna, and through CADDAC (Central Analog Data Distributing and Computing) to the radars. Once the TLM-18 has acquired and is tracking the capsule automatically, its information on capsule azimuth and elevation is available for putting on to the acquisition bus for use by the voice and command transmitting antenna and the radars. Conversely, when one of the radars is tracking automatically, its information is available to the voice and command transmitting antenna and the TLM-18. The transmitting antenna has no

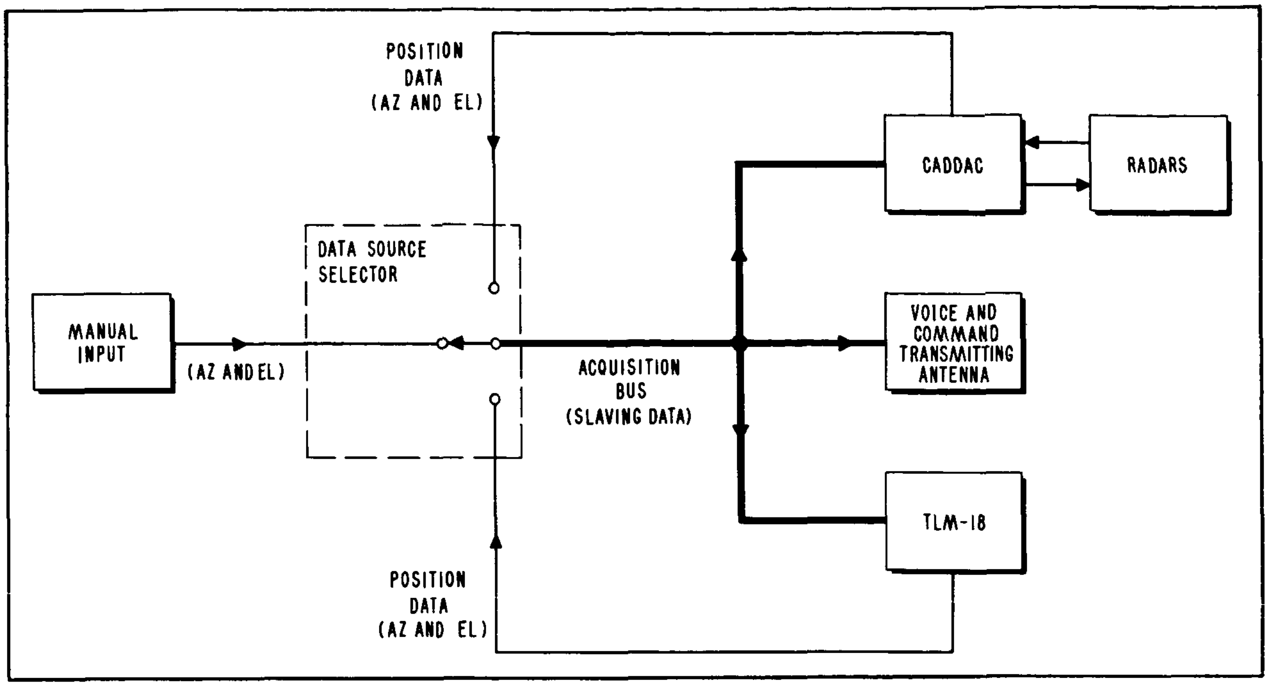


Figure 1-5. Basic Function of Acquisition System

automatic tracking function and therefore cannot supply acquisition information to the radars and the TLM-18. Figure 1-6 is a simplified block diagram of the complete acquisition system. The acquisition bus, which distributes the two channels (azimuth and elevation) of acquisition data, is illustrated by heavy lines. Data from one of the three sources (manual, CADDAC, or TLM-18) is put onto the bus by the data source selector, which actually consists of several switches and relays in the acquisition data console. From the data source selector, the bus goes to the synchro line amplifier and the transmitter section of one of the two synchro remoting transmitter-receivers. From the synchro line amplifier, the bus goes to the TLM-18, where the information on the bus is displayed.

Note

> The TLM-18, although a steerable, automatic-tracking device, cannot be slaved to external information. Therefore, at the TLM-18, data from the acquisition bus is used only for visual display.

From the transmitter of the first of the synchro remoting transmitter-receivers, the acquisition bus goes to the receiver of the second synchro remoting transmitter-

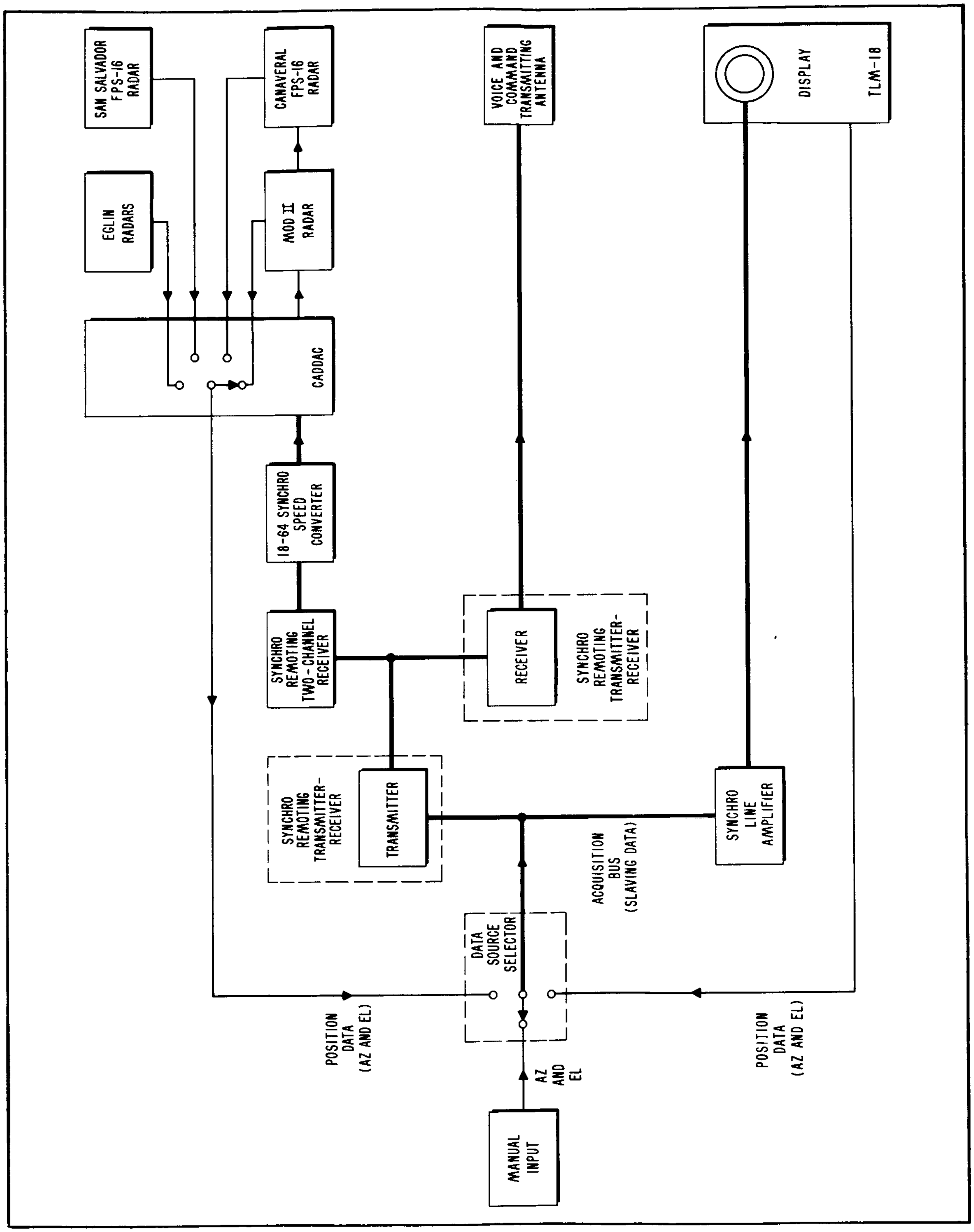


Figure 1-6. Acquisition System, Simplified Block Diagram

receiver and to the synchro remoting two-channel receiver. From the receiver of the second synchro remoting transmitter-receiver, the bus goes to the voice and command transmitting antenna. From the synchro remoting two-channel receiver, the bus goes to the 18-64 synchro speed converter and thence through CADDAC to the Mod II radar. The Mod II radar supplies acquisition information to the Cape Canaveral FPS-16 radar. When the TLM-18 is tracking the capsule automatically, its data output (position data) is available at the data source selector for putting on the acquisition bus. When one or more of the radars is tracking automatically, radar position data is available through CADDAC to the data source selector. Manual data is available whenever the synchro transmitters on the acquisition data console have the necessary information set into them. In addition to the position data from the radars and the TLM-18, display data and operating mode information from the radars, the TLM-18, and the voice and command transmitting antenna are supplied to the acquisition data console. (The paths of the display data and operating mode information are not shown on figure 1-6.)

(2). ACQUISITION DATA CONSOLE

The acquisition data console is the control center of the acquisition system. It contains indicator lights, synchro displays (receivers), and control switches. It also contains synchro-transmitters for putting predicted acquisition data into the system. The inputs to the console, other than primary power, are operating mode information in d-c form, synchro display data, and synchro position data. The operating mode information is used simply to light lamps which indicate the operating mode of the steerable antennas; for instance, automatic tracking, manual tracking, and slaved. Synchro position data is put on the acquisition bus for slaving the voice and command transmitting antenna and the radars and for display at the TLM-18, which cannot be slaved. Synchro display data is displayed by means of synchro receivers on the console. This data is used only for monitoring purposes; it is not put on the acquisition bus for slaving purposes. The functions of the various indicators, displays and controls on the console are described in the following paragraphs; a simplified schematic is shown in figure 1-7.

(a). The d-c indications coming into the console from the voice and command transmitting antenna are "MANUAL" and "SLAVED" mode indications and a "CABLE WRAP" indication. The only synchro data from the voice and command transmitting antenna is azimuth and elevation display data. This data is displayed on two synchro receivers on the console. (Each of the synchro symbols on figure 1-7 represents a pair of synchros, one for azimuth data and one for elevation data.) The mode indicators, which are controlled by an operator at the transmitting antenna servo rack, and the synchro displays allow the acquisition data console operator to monitor the operation of the transmitting antenna insofar as its positioning in azimuth and elevation is concerned. The cable wrap indication permits the acquisition data console operator to determine the azimuth position of the transmitting antenna relative to its cable wrap limits. (The rotation of the antenna is restricted to 540 degrees because of cabling which wraps around the pedestal as it turns.)

(b). The mode indications from CADDAC are "VALID TRACK," "MANUAL," and "SLAVED." These indications show whether the radar which is supplying position data to the console is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The synchro information from CADDAC is azimuth and elevation position data. This data is displayed on a pair of synchro receivers on the console and is available for switching onto the acquisition bus.

(c). The mode indications coming into the acquisition data console from the TLM-18 are "VALID TRACK" and "MANUAL." These indications show whether the TLM-18 is tracking the capsule automatically or is being operated manually. Two separate sets of synchro information come into the console from the TLM-18; these are display data and position data. The display data is displayed on a pair of synchros on the console. The position data, which comes from a separate pair of synchro transmitters on the TLM-18, is available for switching onto the acquisition bus.

(d). Data from the manual input synchro transmitters on the console is displayed by a pair of synchro receivers and is available for switching onto the acquisition bus.

(e). Whatever data has been switched onto the acquisition bus is

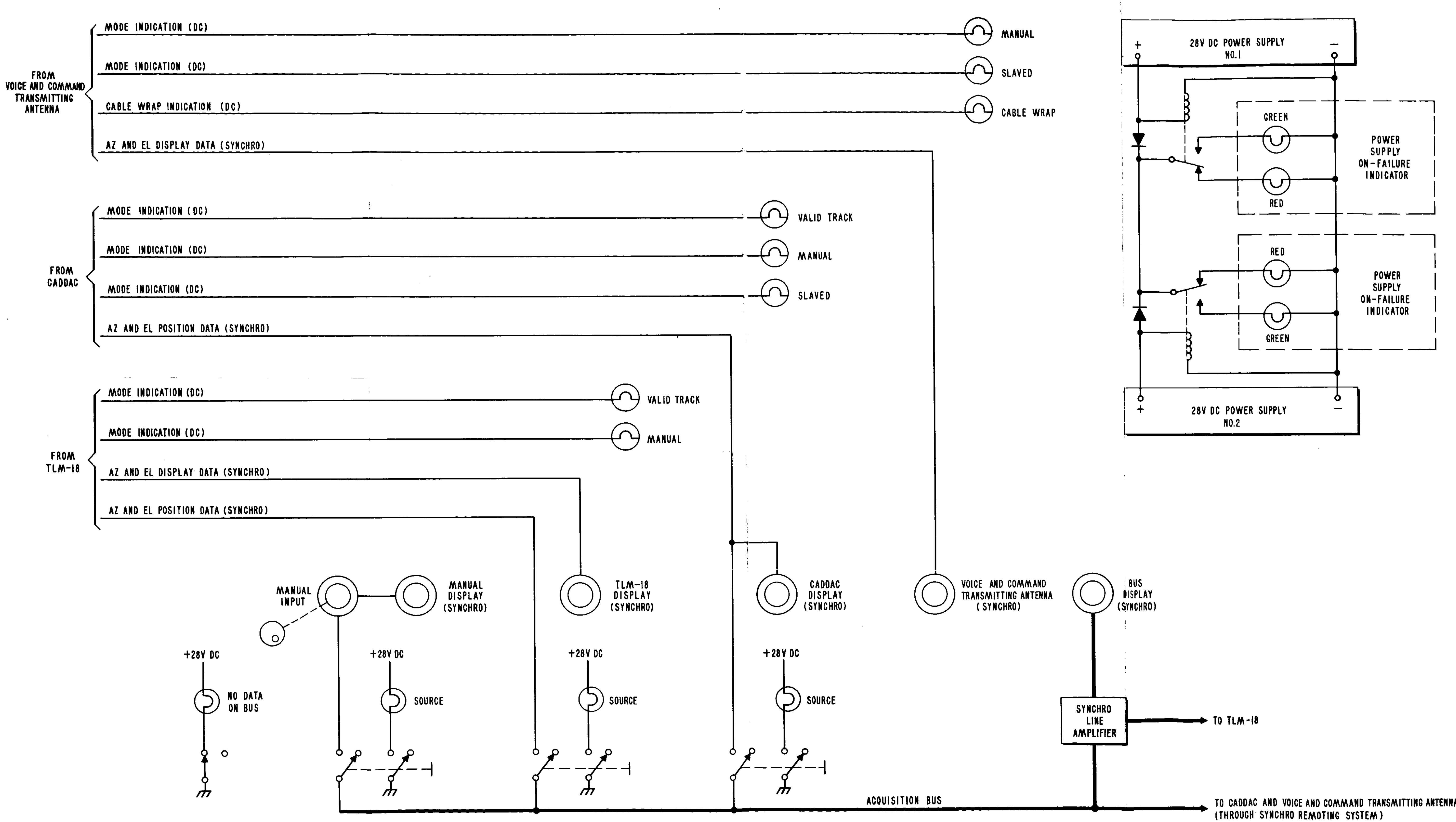


Figure 1-7. Acquisition Data Console, Simplified Schematic Diagram

displayed on a pair of synchro receivers (labeled "bus display" on figure 1-7). The purpose of this display is to provide monitoring of whatever data has been switched onto the acquisition bus and to permit the console operator to compare this data with the display of the source data (from CADDAC, the TLM-18, or the manual input).

(f). Position data from CADDAC, the TLM-18, or the manual input is put onto the acquisition bus by means of switches and relays. These switches and relays are shown on figure 1-7 simply as switches beneath the "MANUAL," "TLM-18," and "CADDAC" displays. These controls, which make up the "data source selector" shown on figures 1-5 and 1-6, are electrically interlocked with each other and with a fourth, the switch in series with the "NO DATA ON BUS" indicator. Thus, data from only one source can be on the acquisition bus at any one time; and when there is no data on the bus, the "NO DATA ON BUS" indicator is lit. "SOURCE" indicators associated with the data selector switches show the source of whatever data has been switched onto the acquisition bus.

(g). There are two 28 VDC power supplies on the acquisition data console, either one of which is capable of supplying all of the power needed to operate the console indicators and controls. Two power supplies are used to increase the reliability of the equipment, and provision is made to disconnect a power supply automatically when its voltage output drops below a certain level. The circuitry which performs this action is shown in simplified form in figure 1-7. Across the output of each of the power supplies there is a control relay whose contacts apply 28 VDC to either a red or a green lamp in the "power supply on-failure indicator." When both power supplies are on and functioning properly, both of the control relays are energized and the green lamps are lit in both indicators. If the voltage output of one power supply drops below a certain value, the control relay associated with that power supply is de-energized and the red lamp in the indicator for that power supply is lit. De-energizing the control relay also causes primary power to be removed from the malfunctioning power supply. (The red indicator lamp is supplied with power from the other, normally-operating power supply.) Note that when one power supply has been turned on and the other has not, a failed indication (red light) is given for the power supply not turned on; the control circuit gives the same indication for a condition of one power supply turned on and one off as it does for both turned on and one malfunctioning.

(3). SYNCHRO LINE AMPLIFIER

The purpose of the synchro line amplifier is twofold: to isolate the TLM-18 and console displays from the acquisition bus so that a malfunction in one of these displays does not degrade the synchro data going to CADDAC and the voice and command transmitting antenna; and to provide low impedance level synchro data to the TLM-18 and console displays. (Synchro data from a low impedance source is less subject to degradation due to loading by the transmission line or the synchro receiver displays than is data from a high impedance source.) The synchro line amplifier has two, identical amplifier channels, one for azimuth data and one for elevation data. Each of the amplifier channels consists of two amplifier elements and a power supply. Each of the amplifier elements is in itself a four-stage, feedback amplifier. The amount of feedback is adjusted so that each amplifier element has a voltage gain of one; thus each amplifier channel in the synchro line amplifier has a voltage gain of one, and the voltage applied to the display synchro receivers in the TLM-18 and the console is the same as that put out by the synchro transmitter. In this manner, isolation and a low impedance source for the synchro data are obtained without changing the voltage level of the data. For a detailed description of the synchro line amplifier, refer to the applicable equipment manual.

(4). SYNCHRO REMOTING SYSTEM

The synchro remoting system is needed to transmit synchro data over relatively long distances without degradation of the data. It consists of a transmitter-receiver near the acquisition data console, a transmitter-receiver near the voice and command transmitting antenna, and a two-channel receiver near the CADDAC input. The transmitter-receiver units are virtually identical, and the two-channel receiver is essentially the same as the receiver portion of the transmitter-receivers. Thus, the complete system consists of two transmitters and three receivers. Both of the transmitters and all three of the receivers handle two channels of data, azimuth, and elevation. A simplified block diagram of the synchro remoting system is shown in figure 1-8. Synchro signals supplied to the transmitter portions of the transmitter-receiver units (slaving data from the acquisition data console and display data from the transmitting antenna) are converted into frequency-multiplexed audio tones in a digital code. These audio tones are transmitted to the receivers, where they are decoded and synchro signals synthesized. The synchro signals synthesized by the receivers are, within the accuracy limitations of the system, the same as the synchro signals fed into the transmitter. In the remoting system, data is represented by frequency, not by voltage, and the accuracy of the system is therefore relatively independent of transmission line characteristics. For a complete description of the synchro remoting system, refer to the applicable equipment manual.

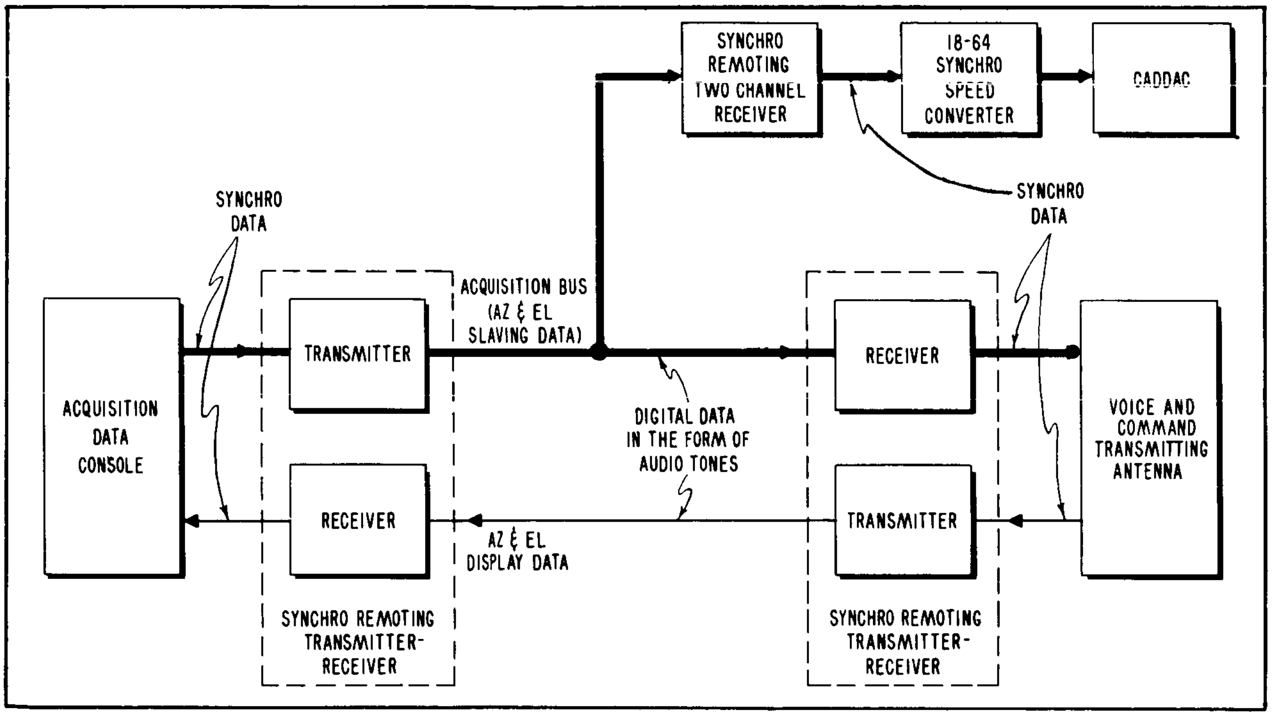


Figure 1-8. Synchro Remoting System, Simplified Block Diagram

(5). <u>18-64 SYNCHRO SPEED CONVERTER</u>

The 18-64 synchro speed converter, shown on figures 1-6 and 1-8, compensates for gearing down in the elevation channel of the Mod II radar by a ratio of 64:18. The 18-64 synchro speed converter steps up the speed of the synchro elevation data from the acquisition bus by a ratio of 18:64 and thus provides to the Mod II an elevation synchro signal which positions the Mod II antenna in a 1:1 correspondence with data from the acquisition bus. The azimuth channel of the Mod II is not geared down and therefore requires no synchro speed conversion. For a complete description of the 18-64 converter, refer to the applicable equipment manual.

(6). TLM-18

The Mercury Control Center TLM-18 is an automatic angle-tracking device which provides acquisition information to the acquisition system for use by the radars and the voice and command transmitting antenna. It tracks the capsule in azimuth and elevation by means of the telemetry signals transmitted from the capsule and puts out azimuth and elevation position and display synchro data. (It also is used for telemetry and UHF voice communications reception; refer to the applicable system manuals.) Although the TLM-18 can track the capsule automatically and its antenna can be manually positioned in azimuth and elevation, it cannot be slaved to external acquisition data. Therefore, the input to the TLM-18 from the acquisition bus is used only for display (by the two synchro receivers on the acquisition bus display panel). The operators read the display and manually position the antenna accordingly until the capsule is acquired and automatic tracking begins. The acquisition outputs of the TLM-18 are taken from two pairs of synchro transmitters (one of each pair for azimuth data, and one for elevation data). One pair of synchros provides position data, and the other pair provides display data.

(7). HF ANTENNA POSITIONING SYSTEMS

The HF antenna positioning systems are used to position HF voice receiving antennas numbers 1 and 2 in azimuth. For each system the control switch on the acquisition data console permits the application of a reversible-phase voltage to the antenna drive motor, thus turning the antenna clockwise or counterclockwise as desired. The synchros in the system (transmitter in the rotator unit and receiver in the indicator unit) provide an indication of the azimuth to which the antenna has been turned.

1-4. SITE IMPLEMENTATION

This paragraph deals with the allocation, location, and housing of contractor-furnished equipment for the acquisition system at Cape Canaveral, Florida.

A. EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at the Cape Canaveral, Florida site is listed in table 1-II.

B. SITE DESCRIPTION

(1). SITE LAYOUT

Acquisition system equipment at Cape Canaveral, Florida is in the Mercury control center, the central control building, and the command control-transmitter area, shown on figure 1-9.

(2). EQUIPMENT LAYOUT — MERCURY CONTROL CENTER

Acquisition system equipment in the Mercury control center building comprises the acquisition data console and a synchro remoting transmitter-receiver. These units are in the locations shown on figure 1-10.

(3). EQUIPMENT LAYOUT — CENTRAL CONTROL

Acquisition system equipment in the central control building consists of the synchro remoting two-channel receiver and the 18-64 synchro speed converter, which is mounted in the two-channel receiver cabinet.

(4). EQUIPMENT LAYOUT — TRANSMITTER VAN

The acquisition system equipment in the transmitter van is a synchro remoting transmitter-receiver. Its location in the van is shown on figure 1-11.

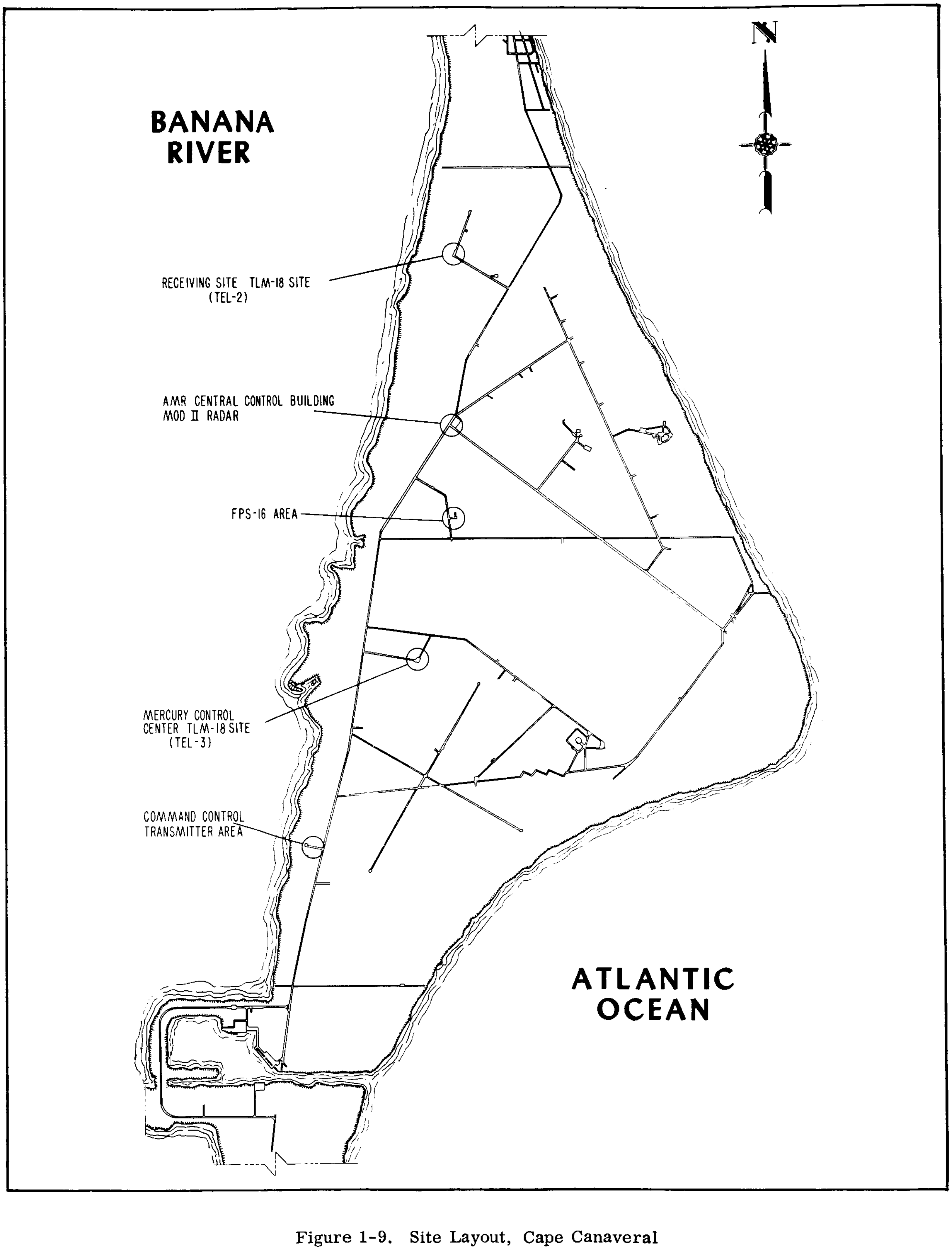


Figure 1-9. Site Layout, Cape Canaveral

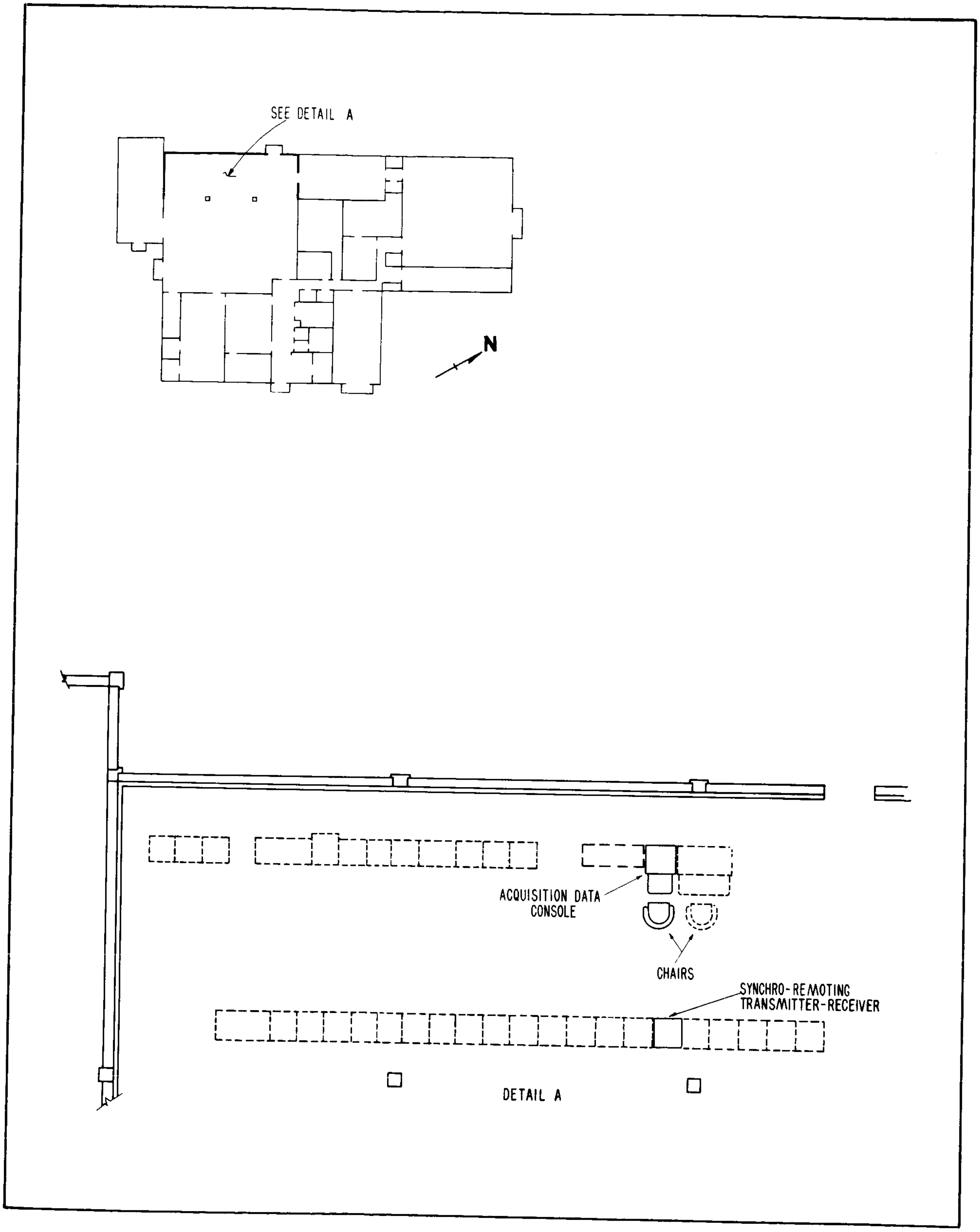


Figure 1-10. Acquisition System Equipment Layout, Mercury Control Center

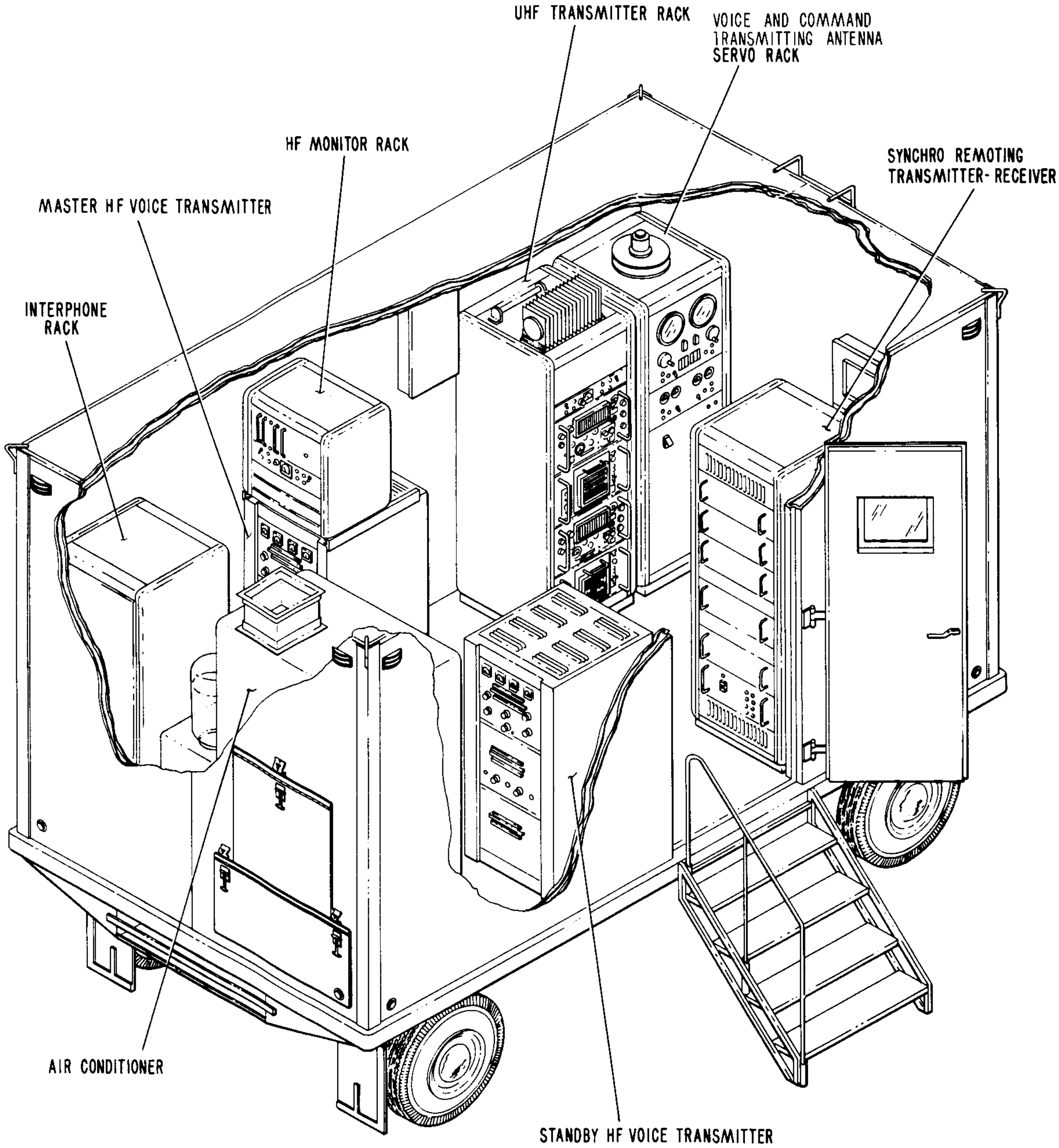


Figure 1-11. Equipment Layout, Transmitter Van

SECTION II
INSTALLATION

2-1. GENERAL

This section comprises instructions and other information for installing the the equipment which makes up the acquisition system at Cape Canaveral, Florida.

2-2. EQUIPMENT INSTALLATION

A. CONSOLE AND CABINETS

The console and cabinet units in the acquisition system which require installation are the acquisition data console, one of the synchro remoting transmitter-receivers (part number 1061778), and the synchro remoting two-channel receiver. (The other synchro remoting transmitter-receiver, part number 1062383, is furnished already mounted in the transmitter van and requires no separate installation.) Figure 2-1 gives the outline dimensions for the units (the synchro remoting two-channel receiver has the same dimensions as the transmitter-receiver which is shown on the illustration). It should be noted that figure 2-1 is a composite illustration; it is not drawn to scale for both sizes of units. The console and cabinets are secured to building floors by lag bolts. Mounting hole locations are shown in figure 2-2. The hardware required for mounting the units is given in table 2-I.

B. SYNCHRO LINE AMPLIFIER

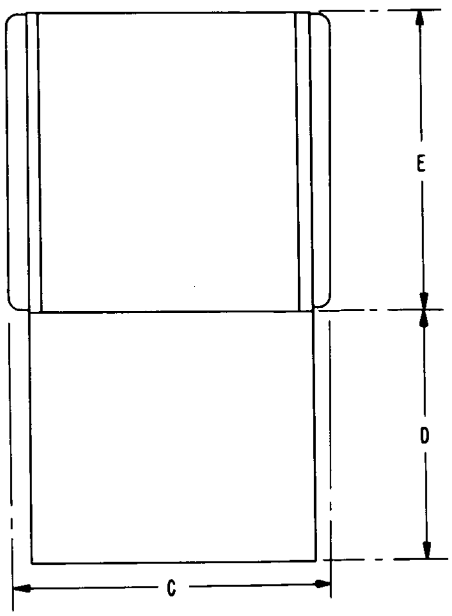
The synchro line amplifier is furnished mounted in the acquisition data console and therefore requires no separate installation.

C. 18-64 SYNCHRO SPEED CONVERTER

The 18-64 synchro speed converter is installed in place of a blank panel in the synchro remoting two-channel receiver as shown in figure 1-4.

D. TLM-18 ACQUISITION BUS DISPLAY PANEL

The TLM -18 acquisition bus display panel is installed as the top panel in the center cabinet of the TLM-18 control installation.



DIMENSIONS IN INCHES		
DIMENSION	ACQUISITION DATA CONSOLE	SYNCHRO REMOTING XMTR-RCVR
A	59-5/8	68-3/8
B	29-9/16	—
C	23-9/16	23-9/16
D	18-1/2	—
E	22	22

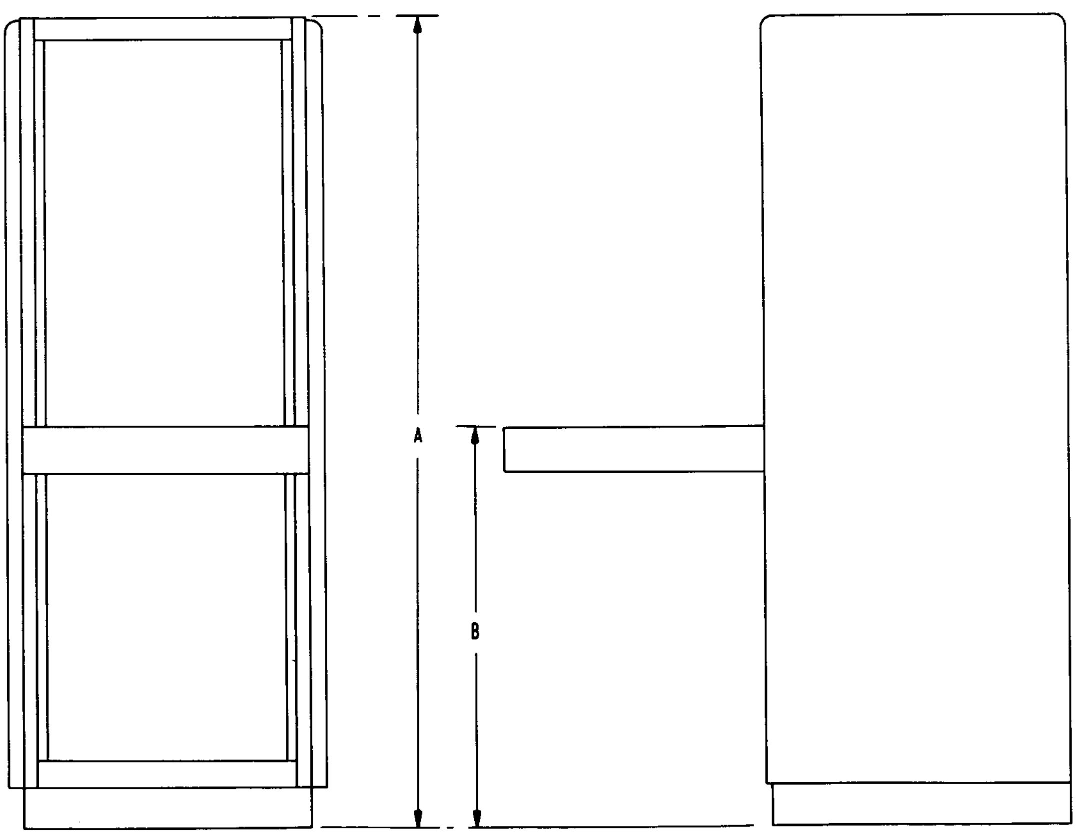


Figure 2-1. Acquisition Data Console and Synchro Remoting System Unit Outline Dimensions

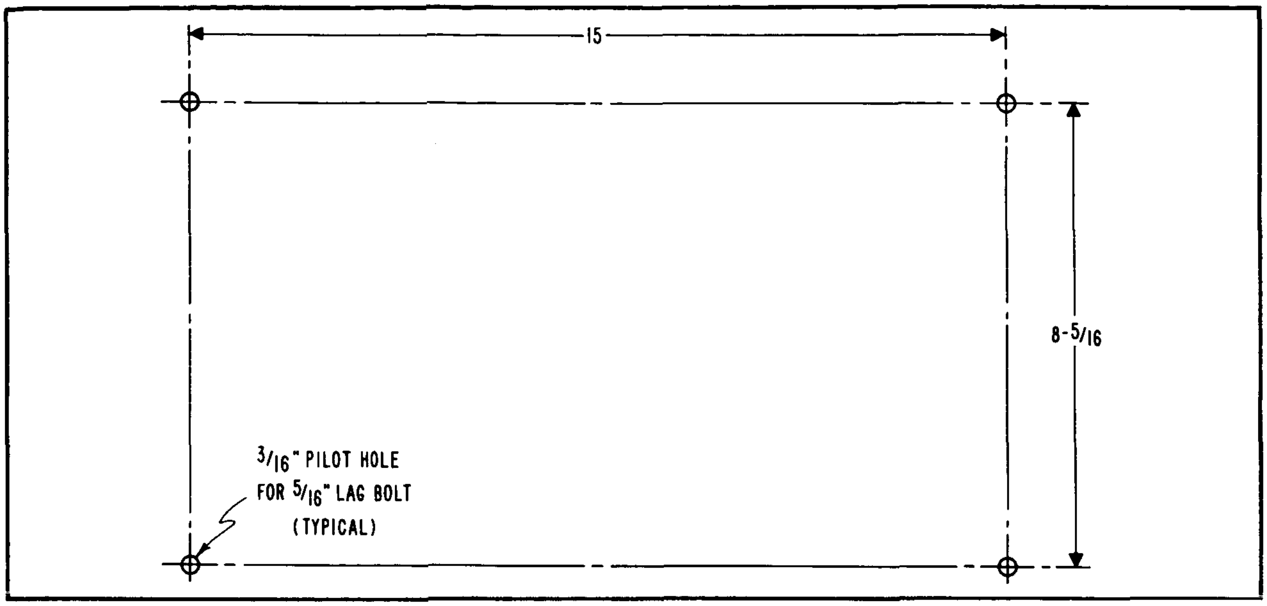


Figure 2-2. Console and Cabinet Mounting Hole Locations

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE

Item	Part Number	Quantity
ACQUISITION DATA CONSOLE (See Figure 2-2.)		
Lag Bolt 5/16 in., 2 in. long	A683349-1	4
Flat Washer, 5/16 in.	HK779S20-A	4
Lock Washer, 5/16 in.	HK779G20-E	4
SYNCHRO REMOTING TRANSMITTER-RECEIVER		
Same as acquisition data console.	-	-
SYNCHRO REMOTING TWO-CHANNEL RECEIVER		
Same as acquisition data console.	-	-

2-3. INTERCONNECTING CABLING

A. ELECTRICAL INTERCONNECTIONS

An interconnecting cabling diagram for the acquisition system is included in Section VII (figure 7-11). This diagram shows all of the interconnections within the acquisition system and the interconnections between the acquisition system and equipment of other systems to which the acquisition system is connected. Detailed interconnecting wiring information is not included in this manual. It is provided in a separate book, "Installation Wiring Information", part number L683173-3.

B. CABLE INSTALLATION

The physical installation of equipment interconnecting cabling is not covered in this manual. It is included in the installation wiring information book (refer to the previous paragraph) and is provided directly to each site on separate drawings.

2-4. PRE-OPERATIONAL CHECKS

A. COMPONENT (UNIT) CHECKS

Pre-operational checks of the components of the acquisition system other than the acquisition data console are given in the individual equipment manuals. Pre-operational checks for the acquisition data console are described in Section III of this manual.

B. SYSTEM CHECKS

No pre-operational checks are required for the overall acquisition system. Operational system checks are described in Section III. It should be kept in mind that any synchro circuit malfunctions which occur the first time the system checks are run are likely to be caused by incorrect interconnecting wiring of the synchro circuits. Refer to Section V and particularly to figure 5-1 for information on trouble shooting synchro circuit malfunctions.

SECTION III
SYSTEM OPERATION

3-1. GENERAL

A. This section contains a tabulation (table 3-I) and illustrations of the controls on the acquisition data console, initial and normal turn-on procedures for system equipment, system operational checks, and normal and emergency system operating procedures. Complete, detailed procedures are included only for the acquisition data console, since detailed procedures for other system equipment are in the various equipment manuals (listed in table 1-II).

B. For proper operation of the acquisition system, it is necessary that all operators involved, and particularly the acquisition data console operator, have a thorough knowledge and understanding of the makeup, capabilities, and limitations of the overall system and the equipment connected to it. Refer to Sections I and IV of this manual.

3-2. INITIAL TURN-ON PROCEDURE

The procedure described in this paragraph is to be followed the first time the equipment is turned on after installation or major repair. For initial turn-on procedures for equipment other than the acquisition data console, refer to the applicable equipment manuals. Proceed as follows for the acquisition data console:

A. EXTERNAL POWER CONNECTIONS

Check the external primary power (115 VAC) to the acquisition data console as follows:

(1). With the acquisition data console circuit breaker on the site power panel off, remove all wires except the external power leads from console terminal board TB6001, terminals 1 and 2.

(2). Turn the circuit breaker on and check to see that 115 VAC is applied to console terminals TB6001-1 and TB6001-2. TB6001-1 should be connected to the "hot" wire and TB6001-2 to the neutral wire. Measure from the terminals to console ground to ascertain which terminal is "hot." (There should be 115 VAC between TB6001-1 and console ground, and no or very little voltage between TB6001-2 and console ground.)

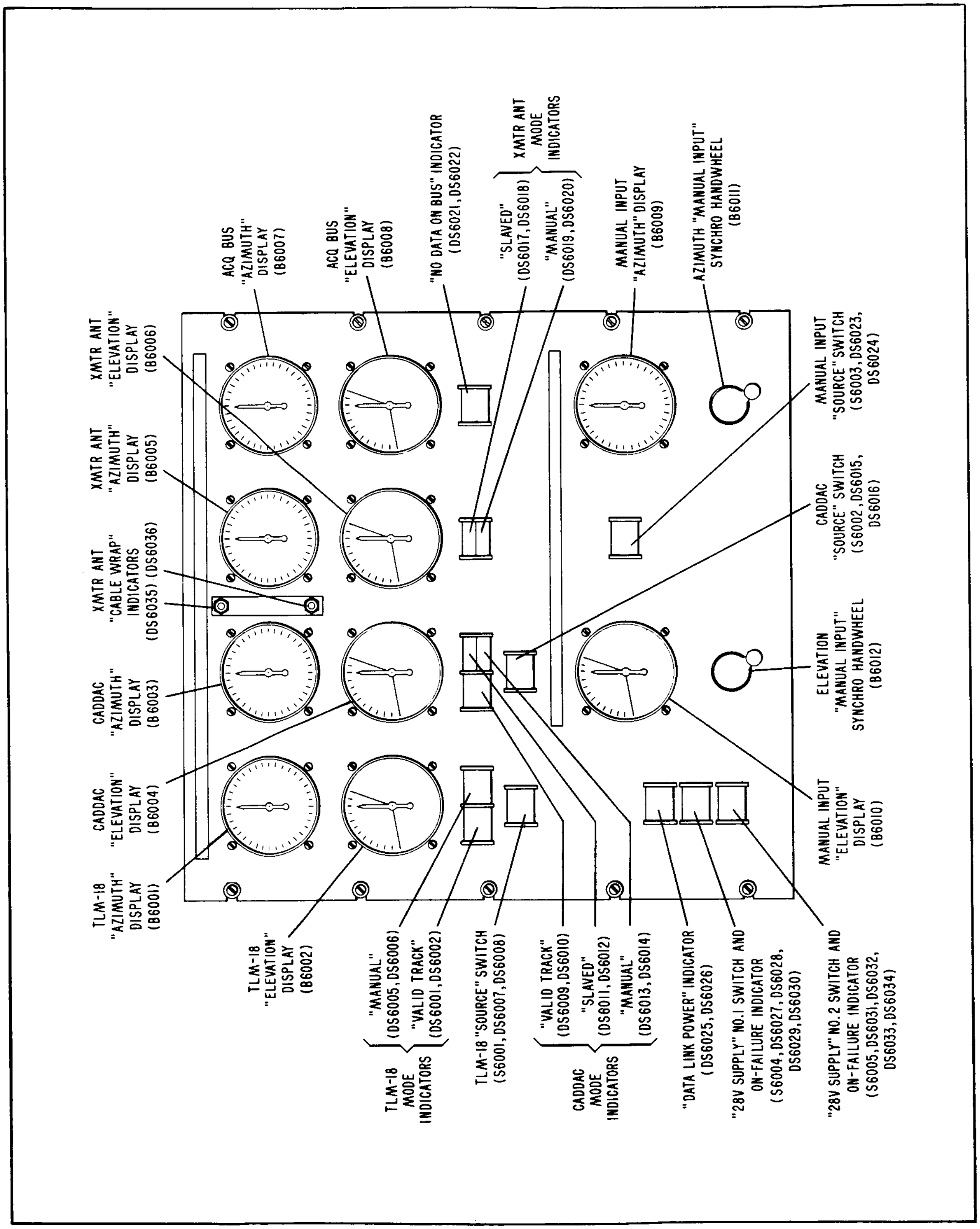


Figure 3-1. Acquisition Data Panel

TABLE 3-I. OPERATING CONTROLS, INDICATORS AND DISPLAYS

Name	Function
ACQUISITION DATA PANEL (See figure 3-1.)	
"28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 2 and indicates whether it is operating properly.
"28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 1 and indicates whether it is operating properly.
"DATA LINK POWER" INDICATOR	Indicates that primary power has been applied to the synchro remoting system.
CADDAC MODE INDICATORS	Indicate whether the radar connected to CADDAC is in automatic tracking, slaved, or manual mode of operation.
TLM-18 "SOURCE" SWITCH	Connects data from the TLM-18 to the acquisition bus.
TLM-18 MODE INDICATORS	Indicate whether the TLM-18 is in automatic tracking or manual mode of operation.
TLM-18 "ELEVATION" DISPLAY	Shows the elevation angle of the TLM-18 antenna.
TLM-18 "AZIMUTH" DISPLAY	Shows the azimuth angle of the TLM-18 antenna.
CADDAC "ELEVATION" DISPLAY	Shows the elevation angle of the radar antenna which is connected to CADDAC.
CADDAC "AZIMUTH" DISPLAY	Shows the azimuth angle of the radar antenna which is connected to CADDAC.
XMTR ANT "CABLE WRAP" INDICATORS	Indicate whether the transmitting antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
XMTR ANT "AZIMUTH" DISPLAY	Shows the azimuth angle of the transmitting antenna.
XMTR ANT "ELEVATION" DISPLAY	Shows the elevation angle of the transmitting antenna.
ACQ BUS "AZIMUTH" DISPLAY	Shows the azimuth angle of data on the acquisition bus.
ACQ BUS "ELEVATION" DISPLAY	Shows the elevation angle of data on the acquisition bus.
"NO DATA ON BUS" INDICATOR	Indicates that none of the "SOURCE" switches has been depressed.

TABLE 3-I. OPERATING CONTROLS, INDICATORS AND DISPLAYS (Cont.)

Name	Function
ACQUISITION DATA PANEL (See figure 3-1.) (Cont.)	
XMTR ANT MODE INDICATORS	Indicate whether the transmitting antenna in in slaved or manual mode of operation.
MANUAL INPUT "AZIMUTH" DISPLAY	Shows angle to which the azimuth manual input transmitter has been turned.
AZIMUTH "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the azimuth manual input transmitter.
MANUAL INPUT "SOURCE" SWITCH	Connects data from the manual input transmitters to the acquisition bus.
CADDAC "SOURCE" SWITCH	Connects data from CADDAC to the acquisition bus.
ELEVATION "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the elevation manual input transmitter.
MANUAL INPUT "ELEVATION" DISPLAY	Shows angle to which the elevation manual input transmitter has been turned.
DUAL POWER SUPPLY (See figure 3-2.)	
OFF-ON SWITCH	Controls application of primary power to the dual power supply.
FUSES	Contain primary power line fuses and indicators to show when a fuse is blown.
POWER-ON INDICATOR	Indicates the application of primary power to the dual power supply.
SYNCHRO LINE AMPLIFIER (See figure 3-3.)	
CHANNEL "OFF-ON" SWITCHES	Each applies power to one amplifier channel.
CHANNEL LINE "COMPENSATION" CONTROLS	Each pair adjusts the gain and balance of one amplifier channel.
CHANNEL "2 AMP" FUSES	Primary power line fuses - one for each channel.
CHANNEL "POWER" ON INDICATORS	Indicate that channel primary power has been turned on.

TABLE 3-I. OPERATING CONTROLS, INDICATORS AND DISPLAYS (Cont.)

Name	Function
INTERCOM PANEL (See figure 3-4)	
DIAL VOLUME CONTROL KEYS	 Adjusts received audio level.
TLM-18 ACQUISITION BUS DISPLAY PANEL (See figure 3-5.)	
ACQUISITION BUS "AZIMUTH" DISPLAY	Shows the azimuth angle of the data on the acquisition bus.
ACQUISITION BUS "ELEVATION" DISPLAY	Shows the elevation angle of the data on the acquisition bus.

(3). Turn the circuit breaker off and reconnect all console wiring to terminals TB6001-1 and TB6001-2.

B. 28 VDC POWER SUPPLY

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-2).

(3). Depress the "28V SUPPLY" number 1 switch on the acquisition data panel (figure 3-1). This action turns on power supply number 1. The on-failure indicator for power supply number 1 should be green and the indicator for power supply number 2 should be red.

(4). Remove the display screens from both of the on-failure indicators. Check to see that all color filters are in place (two red and two green in each indicator). The two lamps in the power supply number 1 indicator with green color filters should be lit, and the two lamps in the power supply number 2 with red color filters should be lit.

(5). Check and, if necessary, adjust the output voltage of power supply number 1 in accordance with the instructions in paragraph 5-4.D.(2).

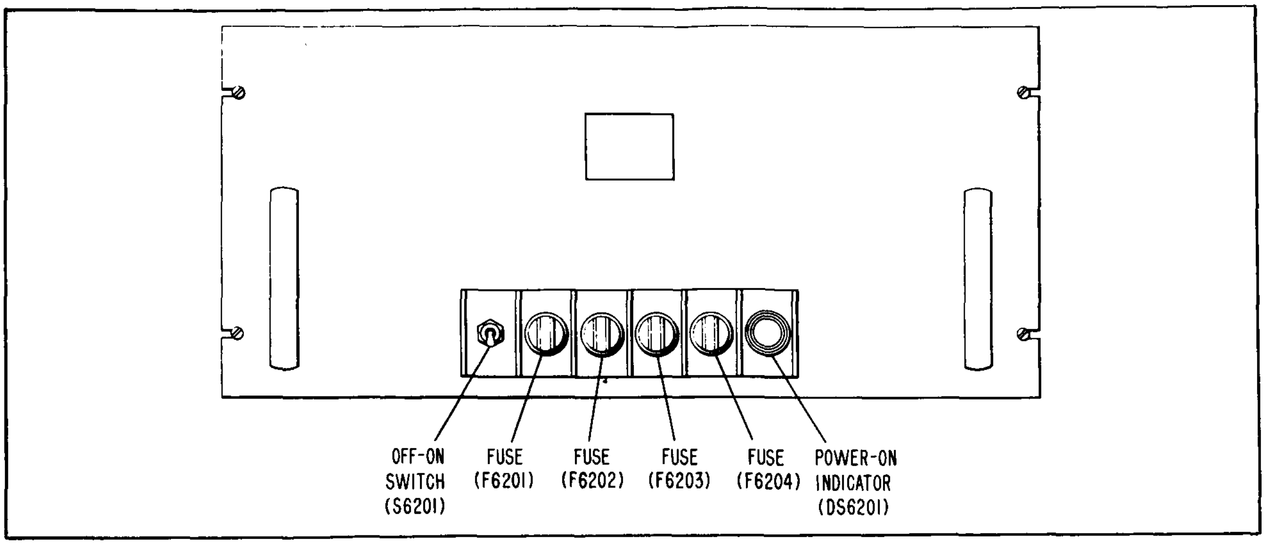


Figure 3-2. Dual Power Supply

(6). Turn off power supply number 1 by turning off the OFF-ON switch on the dual power supply panel.

Note

> Because of the long time constant of the power supply filter, several seconds are required after turning off the power supply before the holding coil of the "28V SUPPLY" switch releases.

(7). Turn on the OFF-ON switch on the dual power supply panel.

(8). Depress the "28V SUPPLY" number 2 switch on the acquisition data panel. This action turns on power supply number 2. The on-failure indicator for power supply number 2 should be green and the indicator for power supply number 1 should be red.

(a). Check the indicators of both power supplies to see that both of the lamps with green color filters in power supply number 2 indicator are lit and that both of the lamps with the red color filters in the power supply number 1 indicator are lit.

(9). Check and, if necessary, adjust the output voltage of power supply number 2 in accordance with the instructions in paragraph 5-4.D.(2).

(10). Depress the "28V SUPPLY" number 1 switch. The on-failure indicators for both power supplies should be green.

C. INDICATORS

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-2).

(3). Depress the "28 V SUPPLY" number 1 and number 2 switches on the acquisition data panel (figure 3-1).

(4). Check the operation of each of the console indicators by completing its circuit with a temporary jumper to ground or 28 VDC. The indicators to be checked in this manner and the associated terminals to be jumpered to ground or 28 VDC are listed in table 3-II. A ground connection for the jumpers can be obtained at TB6001-4 or any convenient place on the console. Twenty-eight volts d-c can be obtained at TB6001-3 or any of several other terminals as shown on figure 7-1. As each of the indicators is lighted, remove its display screen to see that both color filters are in place and that both lamps are working (except for the cable wrap indicators, which have no color filter and only one lamp).

D. SOURCE SWITCHES (FIGURE 3-1)

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel and depress "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel (figure 3-2).

(3). The "NO DATA ON BUS" indicator should be lit. Remove the display screen and check that both color filters are in place and that both lamps are lit.

(4). Depress the manual input "SOURCE" switch. The switch should remain depressed, and its indicator lamps should light. The "NO DATA ON BUS" indicator should go out. Check the color filters and lamps with the display screen removed.

TABLE 3-II

INDICATOR CHECKOUT PROCEDURE

Indicator	Terminal To Be Jumpered	Jumper Connection
TLM-18 "VALID TRACK" (DS6001, DS6002)	TB6011-5	Ground
TLM-18 "MANUAL" (DS6005, DS6006)	TB6011-6	Ground
Transmitting Antenna "SLAVED" (DS6017, DS6018)		(see note 1)
Transmitting Antenna "MANUAL" (DS6019, DS6020)	TB6017-5	Ground
Transmitting Antenna "CABLE WRAP" (DS6035)	TB6017-3	Ground
Transmitting Antenna "CABLE WRAP" (DS6036)	TB6017-2	Ground
CADDAC "VALID TRACK" (DS6009, DS6010)	TB6012-5	Ground
CADDAC "SLAVED" (DS6011, DS6012)	TB6012-3	Ground
CADDAC "MANUAL" (DS6013-DS6014)	TB6012-4	Ground
"DATA LINK POWER" (DS6025, DS6026)	TB6012-6	28 VDC

Note 1: The transmitting antenna "SLAVED" indication is provided through a normally closed relay contact and therefore with normal operation of the console should appear at all times except when the antenna has been switched into the manual mode.

(5). Depress the TLM-18 "SOURCE" switch. The manual input "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The TLM-18 "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(6). Depress the CADDAC "SOURCE" switch. The TLM-18 "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The CADDAC "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

E. SYNCHROS, SYNCHRO LINE AMPLIFIER, AND 18-64 CONVERTER

There is no convenient means of performing checks on the synchros, synchro line amplifier, and 18-64 synchro speed converter without operation of the entire acquisition system and all of the equipment connected to it. Therefore, the initial check of these items should be made during the first system operational check (paragraph 3-5).

F. INTERCOM PANEL

For information on the intercom equipment, refer to the Intrasite PBX and Intercom System Manual, MS-109.

3-3. NORMAL TURN-ON PROCEDURE

A. For normal turn-on procedures for all equipment other than the acquisition data console, refer to the applicable equipment manuals.

B. For normal turn-on of the acquisition data console, proceed as follows:

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-2).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches (figure 3-1). Both of the associated indicators should come on and should be green. The acquisition data console is now ready for operation.

3-4. NORMAL OPERATING PROCEDURE

Paragraph 3-4. A. presents operating instructions for the acquisition system without specifying when and under what conditions the various functions are to be performed. The latter information is given in paragraph 3-4. B. Paragraph 3-4. C. gives instructions for operating the HF antenna positioning systems.

A. OPERATING INSTRUCTIONS

(1). Turn on the acquisition data console in accordance with paragraph 3-3.

(2). Turn on the synchro line amplifier by turning on both of the channel "OFF-ON" switches. The "POWER ON" indicators should come on. (See figure 3-3.)

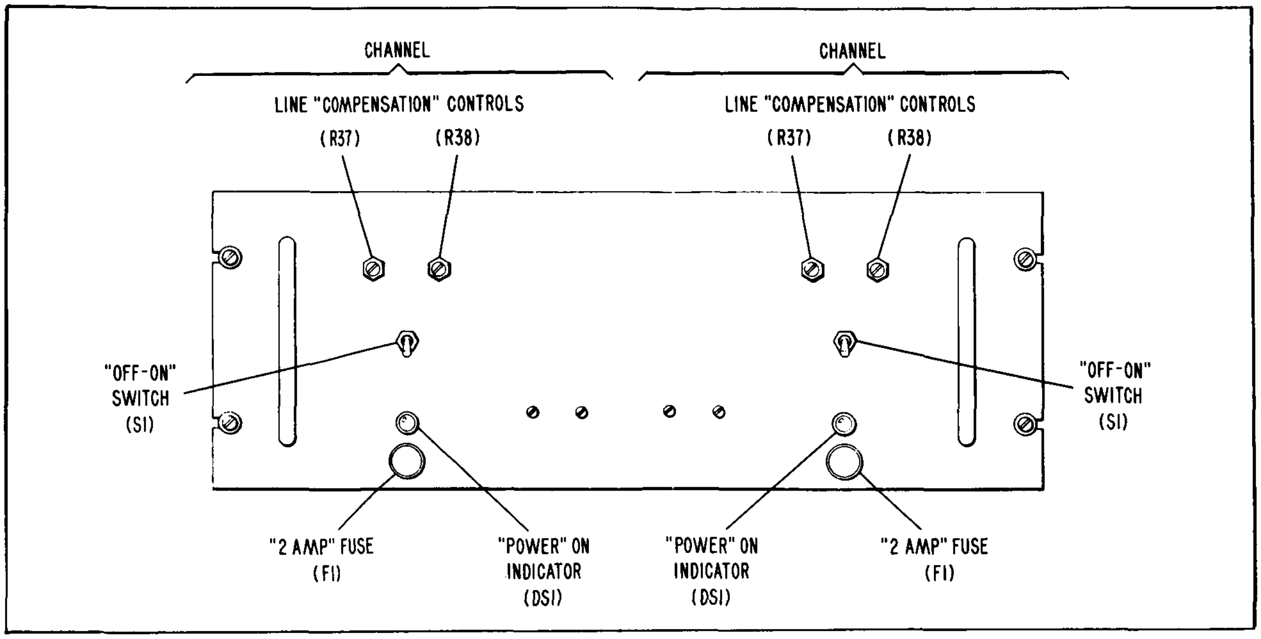


Figure 3-3. Synchro Line Amplifier

(3). Turn on the synchro remoting system transmitter-receiver in the Mercury control center and by intercom direct that the other two synchro remoting system units and the 18-64 converter be turned on.

(4). If the manual input is to be used, set the handwheels (figure 3-1) so that the associated displays are at the desired azimuth and elevation.

(5). By intercom, instruct the operators of CADDAC and the transmitting antenna to disconnect their equipment from the acquisition bus and stand by for further instructions.

(6). Check the d-c mode indications (figure 3-1) from the transmitting antenna to see that it is in the manual mode of operation. CADDAC should be in the manual or automatic mode, and the TLM-18 will of course be in manual or automatic.

(7). Check the "DATA LINK POWER" indicator. It should be on, indicating that primary power has been applied to all of the synchro remoting system units.

CAUTION

The purpose of disconnecting equipment from the acquisition bus before connecting data to it is to avoid sudden, large changes in the inputs to the antenna positioning systems. Such step-function inputs impose unnecessary wear on the equipment, and under certain circumstances can drive the transmitting antenna into its azimuth or elevation limit stops.

(8). Connect the desired source of data (manual, TLM-18, or CADDAC) to the acquisition bus by depressing the proper "SOURCE" switch (figure 3-1). The source switch indicator should light and the switch should remain depressed after being released. The "NO DATA ON BUS" indicator should go out.

(9). By intercom, instruct the operators of all equipment which has not been selected as the source of the acquisition data to set their antennas to the approximate azimuth and elevation which have been connected to the bus. The azimuth and elevation data connected to the bus are shown on the ACQ BUS displays (figure 3-1).

(10). Check the position of the antennas on the console displays and then instruct the operators of equipment which has not been selected as the source of data that they may slave their antennas to the acquisition bus. The TLM-18 cannot be slaved, but if it has not been selected as the source of data and is not in automatic tracking, it should be manually pointed in accordance with data shown on the acquisition bus display panel (figure 3-4).

CAUTION

Be sure that the position of the transmitting antenna is correct before it is slaved to the acquisition bus. Otherwise, it may be driven into its azimuth or elevation limit stops.

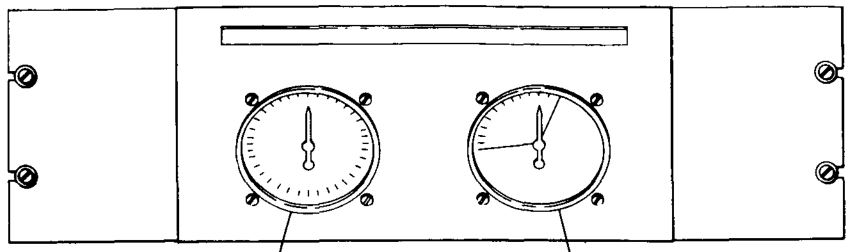


Figure 3-4. TLM-18 Acquisition Bus Display Panel

(11). Check the d-c mode indicators to see that the transmitting antenna is slaved to the acquisition bus. If CADDAC has been selected as the source of data for the acquisition bus, it cannot be slaved to the bus. If the manual input has been selected as the source of data, slaving of CADDAC to the bus is at the option of the CADDAC operator.

(12). Check the console displays from the transmitting antenna to see that it is in the proper location in regard to its cable wrap limits. The upper "CABLE WRAP" indicator should be lit if the pointer of the associated "AZIMUTH" display is in the upper half of the dial, and the lower indicator should be lit if the pointer is in the bottom half of the dial. (Refer to paragraph 4-2. B. (4). (a). and figure 4-7 for complete information on antenna position relative to cable wrap limits.)

(13). Check the system slaving accuracy: The console bus displays and displays of data from the slaved antennas should not differ by more than ±3.0 degrees from the console displays of data from the selected source.

(14). To change from one source of acquisition bus data to another, proceed as follows:

(a). Check the azimuth displays of the two data sources (the one to be switched off the bus and the one to be switched onto the bus) to see that switching from one to the other does not drive the transmitting antenna into its limit stops. Synchro devices and servo systems using them always turn in the direction which results in the lesser amount of rotation in turning to a new, switched-in position; when a receiver is switched to a transmitter with a position different from that of the receiver, the receiver always turns 180 degrees or less — never more than 180 degrees. Thus if a limit lies between the positions of the transmitting antenna and the new source in the direction of lesser rotation, switching to the new source will drive the transmitting antenna into its limit. When this circumstance exists, instruct the transmitting antenna operator by intercom to disconnect his antenna from the acquisition bus and manually set it at the approximate position of the new data source.

(b). Connect the new source of data to the acquisition bus by depressing the appropriate "SOURCE" switch. This action also disconnects the previous source.

(c). If the transmitting antenna has been disconnected from the bus in accordance with step (a), check its position and instruct the operator to slave it to the bus.

(d). Check the condition of cable wrap and system slaving accuracy as directed in preceding steps (10) and (11).

B. OPERATING CRITERIA

The preceding paragraph has described how to perform various functions in the operation of the acquisition system. This paragraph describes when and under what conditions the functions are to be performed.

(1). PREPARATION FOR CAPSULE PASS

(a). Perform the system operational checks described in paragraph 3-5.

(b). Set the acquisition data console manual input in accordance with predicted data.

(c). Connect the manual input to the acquisition bus and notify the CADDAC and transmitting antenna operators to slave their equipment to the acquisition bus. Notify the TLM-18 operator to point the TLM-18 antenna in accordance with data shown on the acquisition bus display panel.

(2). INITIAL ACQUISITION - CADDAC AND TLM-18

Procedures for initial acquisition with CADDAC are outside the scope of this manual. For initial acquisition with the TLM-18, refer to the applicable equipment manual.

(3). INITIAL ACQUISITION - ACQUISITION DATA CONSOLE

(a). As soon as notification is received from CADDAC or the TLM-18 (by d-c mode indications or verbal communication) that automatic tracking data is available, switch this data onto the acquisition bus.

(b). As better automatic tracking data becomes available, switch it onto the acquisition bus. The order of preference of automatic tracking data is as follows:

1. CADDAC data originating at Cape Canaveral.
2. TLM-18 data.
3. CADDAC data originating at the Eglin site. (It will be necessary to determine the origin of CADDAC data by verbal communication with the CADDAC operator.)

Note

The order of availability of automatic tracking data will usually be the inverse of the order of preference. Therefore, it usually will be necessary to switch from CADDAC (originating at Eglin) to TLM-18 to CADDAC (originating locally) during the initial stages of a capsule pass.

(4). TRACKING

After initial acquisition the operating procedure for the acquisition data console is simply to keep the best available data on the acquisition bus. The order of preference for automatic tracking data is as described in the preceding paragraph. In the event that all automatic tracking is lost during a pass, proceed as follows:

(a). Switch acquisition data console manual input data onto the bus.

(b). Set the manual input to the best position (estimated or in accordance with predicted data if available) for re-acquisition.

(c). As soon as automatic tracking is re-established, switch data from the best available automatic tracking source onto the acquisition bus.

C. OPERATION OF HF ANTENNA POSITIONING SYSTEMS

Operation of the HF antenna positioning systems consists simply of turning the antennas to the desired azimuths. The turning of each is accomplished by manual operation of the appropriate rotary switch on the acquisition data console intercom panel (figure 3-5). The synchro displays (indicators) on top of the acquisition data console (figure 1-2) show the azimuth to which each antenna has been turned.

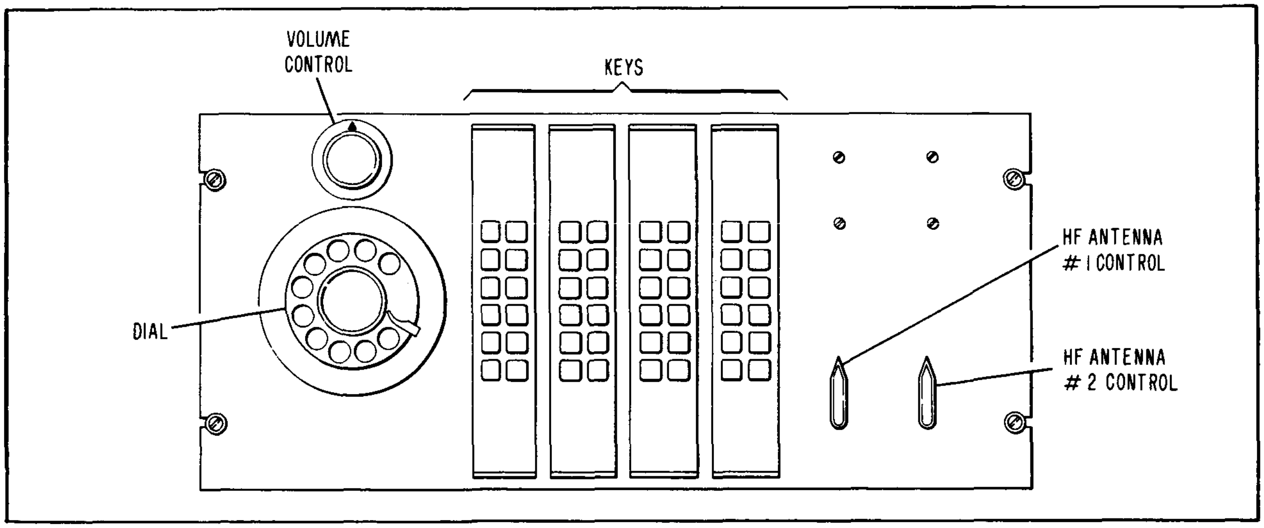


Figure 3-5. Intercom Panel

3-5. SYSTEM OPERATIONAL CHECKS

This paragraph describes the checks to be performed to ascertain that the acquisition data console and the overall acquisition system are in satisfactory operating condition. Detailed procedures for equipment other than the acquisition data console are given in the applicable individual equipment manuals. All of the checks for each individual piece of equipment and for the overall system are to be performed after initial turn-on of the equipment and again shortly before each Mercury operation. Only the operations to be performed are described in this paragraph. For detailed instructions on how to carry out the operations, see paragraph 3-4.

A. D-C INDICATIONS

(1). Check the console 28 VDC power supply and source switches in accordance with the instructions in paragraphs 3-2. B. and D.

(2). Direct the operators of the TLM-18, the transmitting antenna, and CADDAC to switch their equipment successively to all modes of operation; "VALID TRACK" and "MANUAL" for the TLM-18, "SLAVED" and "MANUAL" for the transmitting antenna, and "VALID TRACK," "SLAVED" and "MANUAL" for CADDAC. As the operating modes are switched, check the appropriate console d-c mode indicators (figure 3-1) to see that they light when they should. While each indicator is lit, remove the display screen and see that both color filters are in place and that both lamps are lit.

(3). Check the "DATA LINK POWER" indicator. It should be lit.

(4). Direct the operator of the transmitting antenna to set the antenna to approximately 260 degrees azimuth and then slowly rotate it in the clockwise (increasing azimuth) direction. As the antenna passes 270 degrees, the associated upper (clockwise indicating) "CABLE WRAP" indicator on the acquisition data console should light. Direct the operator to set the antenna at approximately 280 degrees and then slowly rotate it in the counterclockwise direction. As the antenna passes 270 degrees, the associated lower "CABLE WRAP" indicator should light.

B. SYNCHROS, SYNCHRO LINE AMPLIFIER, AND 18-64 CONVERTER

(1). Set the acquisition data console manual inputs to zero degrees azimuth and elevation and switch this data onto the acquisition bus.

(2). Direct the operators of the transmitting antenna and CADDAC to slave their antennas to the acquisition bus, and direct the TLM-18 operator to set the TLM-18 antenna at the azimuth and elevation shown on the acquisition bus display panel.

(3). Check the acquisition bus displays and the displays of antenna position on the acquisition data console and have the other equipment operators check their local displays. The acquisition bus displays and all of the antenna position displays should agree with the manual input displays within ±3. 0 degrees.

(4). With the acquisition data console handwheel change the azimuth manual input from zero to 360 degrees in 30-degree steps and change the elevation manual input from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the console acquisition bus and antenna position displays for agreement with the manual input displays as in the preceding paragraph. (The TLM-18 operator is to position the TLM-18 antenna manually to each step in the check.)

(5). Switch data from the TLM-18 onto the bus.

(6). Have the operator set the TLM-18 antenna to zero degrees azimuth and elevation and then vary it through 360 degrees in azimuth and 90 degrees in elevation in 30-degree steps. At each 30-degree step in azimuth and elevation check the console bus display and all antenna displays. They should agree with the TLM-18 position (as displayed at the TLM-18) within ±3. 0 degrees.

(7). Switch data from CADDAC onto the bus.

(8). Have the operator set the antenna of a Cape Canaveral radar connected to CADDAC to zero degrees azimuth and elevation and then vary it through 360 degrees in azimuth and 90 degrees in elevation in 30-degree steps. At each 30-degree step in azimuth and elevation check the console bus display and all antenna displays. They should agree with the radar antenna position (as displayed at the radar) within ±3. 0 degrees. (The TLM-18 operator is to position the TLM-18 antenna manually to each step in the check.)

3-6. EMERGENCY OPERATING PROCEDURE

Emergency operation of the acquisition system will be required under two general conditions. The first of these conditions is the unavailability of data from a source when it normally should be available. This unavailability could be due either to a malfunction of the source equipment or to simple failure to acquire the capsule. The second condition requiring emergency operation is a malfunction of a component, such as a relay, or a synchro line amplifier, which does not directly affect a data source but which hinders or prevents communication or transmission of data.

Procedures for operation under these two general conditions are discussed in the following paragraphs.

A. OPERATION WITH DATA SOURCE FAILURE

The procedure for operating when data from the normal source is not available is simply to use the next best data which is available. The order of preference of data sources is as follows:

(1). Cape Canaveral radar (connected through CADDAC) in automatic tracking.

(2). TLM-18 in automatic tracking.

(3). Eglin radar (connected through CADDAC) in automatic tracking.

(4). TLM-18 or radar connected to CADDAC in semi-automatic tracking (one channel automatic, the other manual).

(5). Manual input at the acquisition data console.

(6). Independent manual positioning of antennas in accordance with tracking data read over the intercom system. This manner of operation would apply to a piece of equipment if its connection to the acquisition bus was broken, but other equipment was operative and tracking the capsule.

(7). Independent manual positioning of antennas in accordance with predicted data.

B. OPERATION WITH COMPONENT MALFUNCTION

In many instances if a component fails and cannot be repaired or replaced in the time available, temporary circuit connections can be made which will allow at least limited operation of the system. It is of course impractical to attempt to give specific instructions covering all possible failures; maintenance personnel must have sufficient knowledge of the system to devise temporary fixes on the spot. However, to illustrate the types of fixes that might be used, some examples are given in the following paragraphs.

(1). ACQUISITION DATA CONSOLE 28 VDC POWER SUPPLY

(a). Each of the two 28 VDC power supplies in the acquisition data console is capable of easily supplying all of the current needed in the console and 28-volt devices connected to it. Therefore, failure of one supply reduces the reliability of the console, but does not make it inoperative.

(b). Should both of the console 28-volt supplies fail, 28 VDC can be supplied to the console from other, nearby equipment (preferably the communication technicians console): Turn off the dual power supply OFF-ON switch (figure 3-2) and check the console 28 VDC bus to see that it is not shorted to ground. Jumper any convenient terminal on the console 28 VDC bus (for example, TB6001-3; see figure 7-1) to a source in other equipment which can supply about one ampere in addition to its normal load. (The communication technicians console 28 VDC supply easily meets this requirement.) Also connect a jumper between acquisition data console ground and the negative side of the external 28-volt supply. The acquisition data console can now be operated normally except for turning 28 VDC off and on.

(2). RELAYS

Defective relays can be "fixed" by jumpering the normally-open terminals. For instance, should the acquisition data console relay (K6005) which connects data from the TLM-18 to the acquisition bus fail, data from the TLM-18 can be connected to the bus by placing jumpers between terminal boards TB10 and TB15. (See figure 7-1.)

(3). SYNCHRO LINE AMPLIFIER

The synchro line amplifier can be temporarily "fixed" by removing it from the circuit and jumpering its inputs to the corresponding outputs. However, to do so introduces a 180-degree phase shift in the synchro data which normally is connected through the amplifier, and compensating adjustments to the affected circuits must be made.

(4). SYNCHROS

A defective synchro in a critical place can be replaced by another synchro from a less critical place. For example, if the elevation manual input synchro receiver on the acquisition data console fails, it can be replaced by the transmitting antenna elevation display synchro receiver on the console.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

A. With the exception of the acquisition data console, which is treated in detail, this section presents the theory of operation of the acquisition system on a block diagram level. Adjoining systems, those which receive information from or supply information to the acquisition system, are treated only to the extent of their interconnections with the acquisition system. For further information on these systems, see the applicable system manuals. For detailed information on the components of the acquisition system which are described only on a block diagram level, see the applicable equipment manuals. These manuals are listed in table 1-II.

B. As was described in Section I, the function of the acquisition system is to take the best (most accurate) data available on the capsule's azimuth and elevation at any given time and make it available on the acquisition bus for use by the TLM-18, the Cape Canaveral radars, and the voice and command transmitting antenna. (The acquisition bus is the "common" line which distributes data to the using equipment.) The TLM-18 and the radars use the data from the acquisition system as an aid in acquiring the capsule for automatic tracking. As soon as they begin automatic tracking, the TLM-18 and the radars stop using data from the acquisition system; however, under most conditions during a pass, acquisition data is still available to the TLM-18 and the radars for use in re-acquiring the capsule if automatic tracking is lost before the capsule is out of tracking range. The transmitting antenna cannot track a target automatically; therefore, it is normally slaved to data from the acquisition system at all times during a pass.

C. Data inputs to the acquisition system are available from three sources: manual input, the TLM-18, and one of the radars. (Not all three inputs are available all of the time however.) At the acquisition data console the best of the available data is switched onto the acquisition bus and thereby made available to the TLM-18, the radars, and the transmitting antenna.

(1). The manual input to the acquisition system is made with synchro transmitters on the acquisition data console. These synchros are positioned by means of handwheels in accordance with predicted capsule azimuth and elevation data based on computations of the capsule's orbit. This predicted data is transmitted to the site from Goddard Space Flight Center and relayed to the acquisition data console operator through the site intercom system.

(2). Acquisition data from the TLM-18 is taken from synchro transmitters which are mechanically coupled to the TLM-18 antenna. This data is transmitted to the acquisition data console.

(3). Acquisition data is available from one of five radars. These five are the Cape Canaveral Mod II, the Cape Canaveral FPS-16, the San Salvador FPS-16, the Eglin FPS-16, and the Eglin MPQ-31. The selection of which radar supplies data to the acquisition system is made as follows: At Eglin, either the FPS-16 or the MPQ-31 is selected. The data from the Eglin radar selected is transmitted to the CADDAC system at Cape Canaveral. The Cape Canaveral Mod II and FPS-16 and the San Salvador FPS-16 are connected directly into CADDAC, where data from one of these or from Eglin is selected as an input to the acquisition system. Thus, of the five radars, one of two is selected at Eglin; then one of four is selected at CADDAC. Note that all of the selection between the five radars is external to the acquisition system. The acquisition data console operator can use or not use radar data, but he cannot select which of the radars is to make the data available.

D. The following is a description of the normal sequence of availability, distribution, and use of acquisition information during a typical pass of the capsule. This description is given as an aid in understanding the overall operation of the acquisition system. It should be noted, that there are a number of possible variations from the normal sequence. These variations are not discussed in the following description, but should be apparent once the capabilities of the system are understood.

(1). Prior to the pass, predicted target position coordinates—azimuth, elevation, range and time—are sent to the site in plain text from Goddard Space Flight Center. Coordinates for four or five different times along the orbit are sent: time of arrival at 700 nautical miles range, 30 seconds later, 60 seconds later, 90 seconds later, and time for position just past zenith when a zenith pass of the capsule is expected. The first set of coordinates is read over the intercom to the acquisition data console operator, who sets the manual input synchros accordingly and connects them to the acquisition bus. The transmitting antenna and the Mod II radar are slaved to this acquisition data, and the Cape Canaveral FPS-16 is slaved in turn to the Mod II; the operators of the TLM-18, which cannot be slaved, observe the acquisition data as displayed on synchro receivers on the acquisition bus display panel and manually train the TLM-18 to the indicated azimuth and elevation. If acquisition (automatic tracking) of the capsule has not been accomplished, the next three of the remaining sets of coordinates are read and set into the system at the times given. The coordinates just past zenith are used as an aid in re-acquiring the capsule if automatic tracking is lost as it passes overhead.

(2). The Eglin MPQ-31 acquires the capsule, and data from this radar is transmitted to CADDAC at Cape Canaveral. At CADDAC, Eglin radar data is selected by switching and is transmitted to the acquisition data console. The acquisition data console operator removes the manual input and puts the data from CADDAC (originating at Eglin) on the acquisition bus. The transmitting antenna and TLM-18 continue to use the data on the bus as before, but, since it is supplying the input to the acquisition system, CADDAC is disconnected from the bus. (CADDAC cannot supply the input to and receive the output from the acquisition system at the same time.)

(3). The TLM-18 acquires the capsule, begins tracking it automatcially, and supplies data to the acquisition data console. Data from the TLM-18 is preferred to Eglin data (which at this time is the output of CADDAC); hence, the CADDAC data is removed from the acquisition bus and TLM-18 data is put on. The transmitting antenna remains slaved to the acquisition bus, and CADDAC, since it is no longer supplying the input to the acquisition system, is again slaved to the bus.

(4). One of the Cape Canaveral radars acquires the capsule and begins tracking. CADDAC is disconnected from the acquisition bus, and radar data is supplied through CADDAC to the acquisition data console. The acquisition data console operator removes the TLM-18 data from the bus and puts Cape Canaveral radar data (which is now the output of CADDAC) on. The transmitting antenna remains slaved to the acquisition bus, and the TLM-18 continues in automatic track. These conditions — radar in automatic track, transmitting antenna slaved through the acquisition system to the radar, and the TLM-18 in automatic track, independent of the acquisition system — are the optimum for the remainder of the pass. They are continued until the capsule goes beyond the range of the radar or the TLM-18.

(5). If the capsule goes out of range of the TLM-18 before it is out of range of all the radars, the TLM-18 is manually pointed in accordance with the radar data on the acquisition bus until all of the radars have lost the track. If the capsule is still in TLM-18 range after it goes beyond radar range, TLM-18 data is switched onto the acquisition bus. In either event, the transmitting antenna remains slaved to the data on the acquisition bus until all automatic tracking ceases.

4-2. DETAILED DISCUSSION

A. DISCUSSION OF OVERALL SYSTEM

This paragraph discusses the complete acquisition system on a block diagram level (see figures 4-1 and 4-2). Subsequent paragraphs discuss individual components and subsystems of the acquisition system and the HF antenna positioning system.

(1). On the acquisition data console at the data source selector, which in actuality consists of several switches and relays, azimuth and elevation data from one of the three possible sources is put onto the acquisition bus. (The acquisition bus is indicated by the heavy lines on figure 4-1.) This data goes to the transmitter portions of one of the synchro remoting transmitter-receivers and to the two-channel synchro line amplifier. From the synchro line amplifier, it is returned to the acquisition data console for display and is supplied to the TLM-18 where it is available in the form of synchro displays for the use of the TLM-18 operators.

(a). The data from the synchro line amplifier which is displayed on the acquisition data console provides the acquisition data console operator an opportunity to monitor what is on the acquisition bus. By comparing the bus display (from the synchro line amplifier) with the display of data from the source which is supplying the bus, the operator can confirm that the proper source selection has been made and can ascertain that the pertinent circuits in the acquisition data console are functioning properly.

(b). When the TLM-18 is automatically tracking the capsule, acquisition data displayed at the TLM-18 is not used. When the TLM-18 is not engaged in automatic tracking, however, the operators train the antenna in azimuth and elevation in accordance with the acquisition data which is displayed (on the acquisition bus display panel) at the TLM-18.

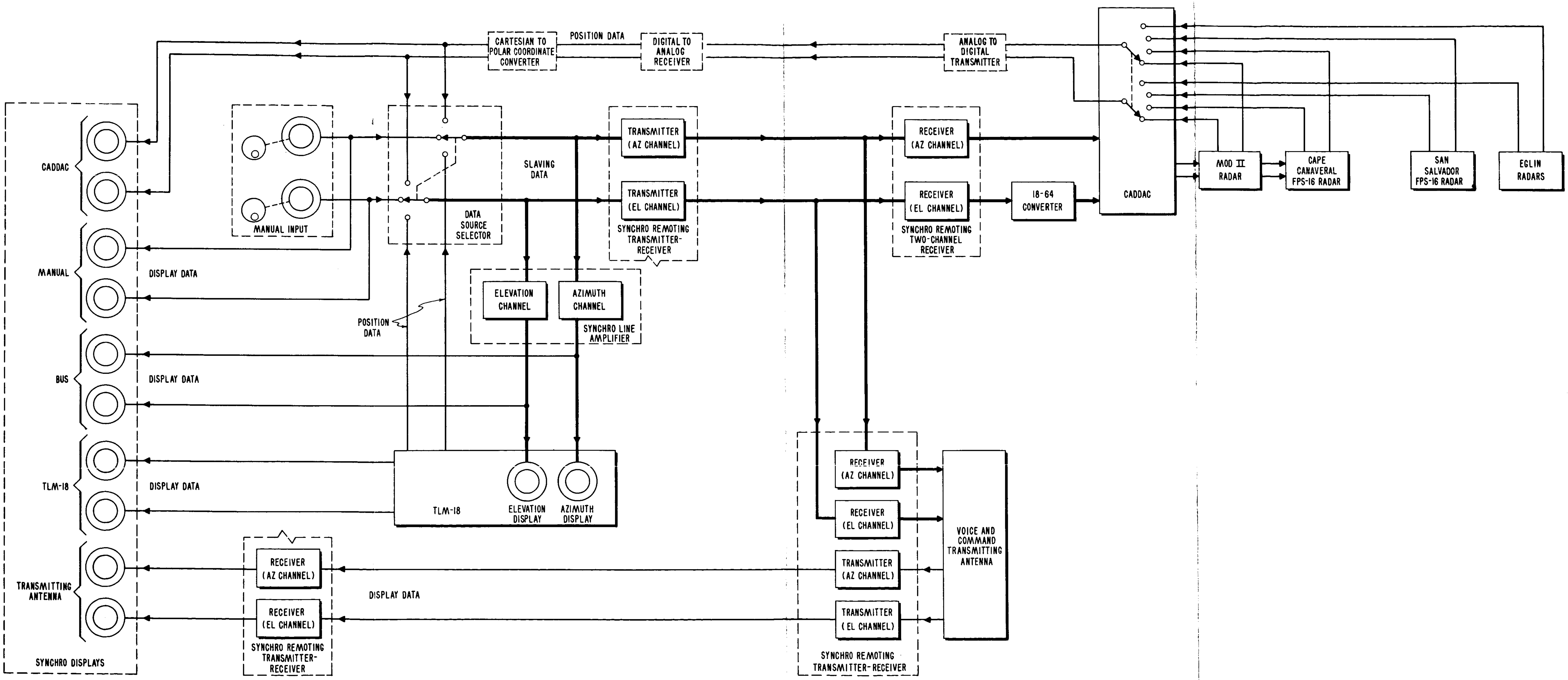


Figure 4-1. Acquisition System, Block Diagram

(2). From the transmitter portions of the synchro remoting transmitter-receiver, data goes to the two-channel receiver near CADDAC and to the receiver portions of the transmitter-receiver unit near the transmitting antenna. From the receiver portions of the unit near the transmitting antenna, the data goes to the antenna. The antenna is normally slaved to this data at all times during a pass of the capsule.

(3). From the two-channel receiver units of the synchro remoting system, azimuth data goes directly to CADDAC. Elevation data, however, goes to CADDAC through the 18-64 synchro speed converter, where it undergoes a step-up synchro speed conversion to make it compatible with the elevation drive system of the Mod II radar. Both azimuth and elevation data are supplied through CADDAC to the Mod II radar. The Cape Canaveral FPS-16 can be slaved to the Mod II radar, but not directly (through switching in CADDAC) to the acquisition bus. As discussed previously, when the output of CADDAC is put on the acquisition bus at the acquisition data console, the Mod II radar cannot be slaved to the data on the bus.

(4). Position and display data are fed to the acquisition data console from the manual input, the TLM-18, the transmitting antenna, and CADDAC. The manual input comprises two synchro transmitters (on the acquisition data console) which are positioned by handwheels; one transmitter and handwheel for azimuth data and one for elevation data. The output of the transmitters goes to the data source selector and to synchro displays.

(5). The TLM-18 puts out azimuth and elevation position data and azimuth and elevation display data. These outputs come from four synchro transmitters, two for position data and two for display data, whose rotors are mechanically coupled to the TLM-18 antenna. Both position and display data are fed to the acquisition data console. The position data is routed to the data source selector where it can be put onto the acquisition bus, and the display data goes to synchro receiver displays for monitoring.

(6). Display data from the voice and command transmitting antenna is fed to the transmitter portions of the synchro remoting transmitter-receiver which is near the antenna. The data goes from these transmitters to the receiver portions of the synchro remoting transmitter-receiver near the acquisition data console and then to synchro displays on the console.

(7). Radar data comes into CADDAC from the Eglin MPQ-31, the Eglin FPS-16 (the selection of one of these is made at Eglin, before the data is transmitted to Cape Canaveral), the San Salvador FPS-16, the Cape Canaveral FPS-16, or the Cape Canaveral Mod II. At CADDAC a selection is made between data from these radars. The selected data is transmitted to the acquisition data console through a system consisting of an analog to digital transmitter, a digital to analog receiver, and a cartesian to polar coordinate converter. (For complete information on this system, refer to the Radar Tracking System Manual, MS-109.) At the acquisition data console, the data from CADDAC is displayed by synchro receivers and is available at the data source selector for switching onto the acquisition bus.

(8). D-c indications of equipment operating mode and of other information are used in the acquisition system. These indications permit the system operators to monitor the status of the various pieces of equipment, and especially they provide the acquisition data console operator with information he needs to control and direct the operation of the system. Four d-c indications come from the voice and command transmitting antenna to the acquisition data console. Two of these are cable wrap indications, and two are operating mode indications. (See figure 4-2.) The cable wrap indications show which half of its total azimuth travel (540 degrees) the transmitting antenna is in, and when used with the azimuth synchro display from the transmitting antenna permit the acquisition data console operator to tell where the antenna is relative to its azimuth limits. The operating mode indications show whether the transmitting antenna is in the slaved or manual mode of operation.

(9). Mode indications from CADDAC are valid track, slaved, and manual. They show the operating mode of the radar or radars connected to CADDAC.

(10). Mode indications from the TLM-18 are valid track and manual; these show the operating mode of the TLM-18.

(11). A power-on indication is received from the synchro remoting system to show that the units of the remoting system are turned on.

B. <u>ACQUISITION DATA CONSOLE</u>

(1). <u>DUAL POWER SUPPLY</u>

Switches, indicators, and relays on the acquisition data console are energized by 28 VDC from the console 28 VDC supply, which consists of a relay

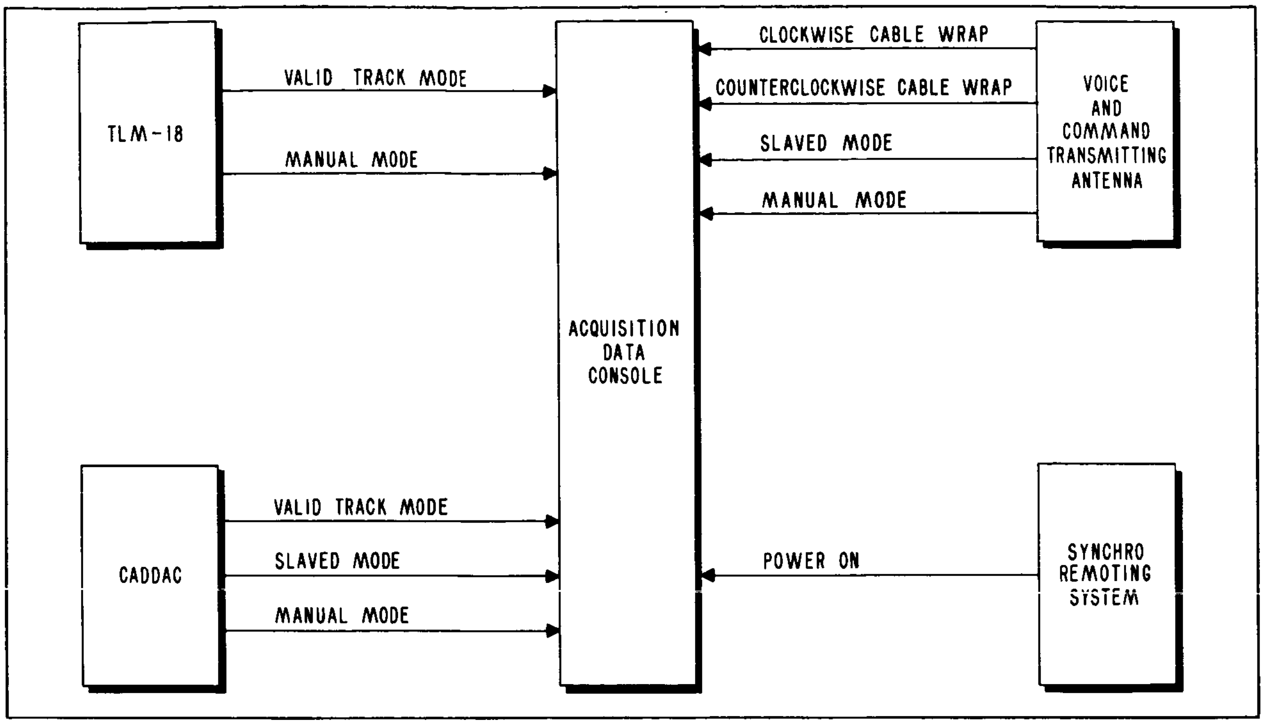


Figure 4-2. Acquisition System D-c Indications, Block Diagram

chassis, two switches on the acquisition data panel, and the dual power supply. The dual power supply consists of four chassis (two power supply units and two filter units) and a front panel. (See figure 7-3.) Primary power, 115 VAC, is applied through jacks J6201 and J6202 to off-on switch S6201. When switch S6201 is closed, primary power is applied through fuses F6201 through F6204 to the primaries of power transformers T6201 and T6202. The fuses are in indicating-type holders; when a fuse blows, a neon bulb in parallel with the fuse is lit. A neon, power-on indicating lamp, DS6201, is across the line going to power supply unit PS6201. Power supply unit PS6201 and filter unit FL6201 make up power supply number 1; it is a conventional d-c power supply with silicon rectifiers in a bridge configuration and with an LC filter. Note that there is a fuse, F6205, on the d-c side of the power supply. This fuse is not in an indicating-type holder. Power supply unit PS6202 and filter unit FL6202 make up power supply number 2, a second d-c power supply which is identical to the first. The secondaries of power transformers T6201 and T6202 have multiple taps to allow adjustment of the output voltage of the power supplies. The voltage difference between taps 1 and 2 is 1.5 VAC and is 3 VAC between taps 3 and 4, 4 and 5, and 5 and

5 and 6. Thus, by connecting the a-c leads to the rectifier to different taps on the transformer, the a-c input to the rectifier can be varied over a range of 10.5 volts (rms), and the d-c output of the power supply over a range of approximately 14.5 volts.

(2). POWER SUPPLY CONTROL CIRCUITS

The control circuits for the console power supply are shown on figure 4-3. Each of the blocks on figure 4-3 labeled "28 VDC POWER SUPPLY" represents half of the dual power supply discussed in the previous paragraph and shown on figure 7-3. Switches S6004 and S6005 and the indicator lamps are on the acquisition data panel; the rest of the components of the control circuits are on the relay chassis (mounted on the side of the console, near the acquisition data panel).

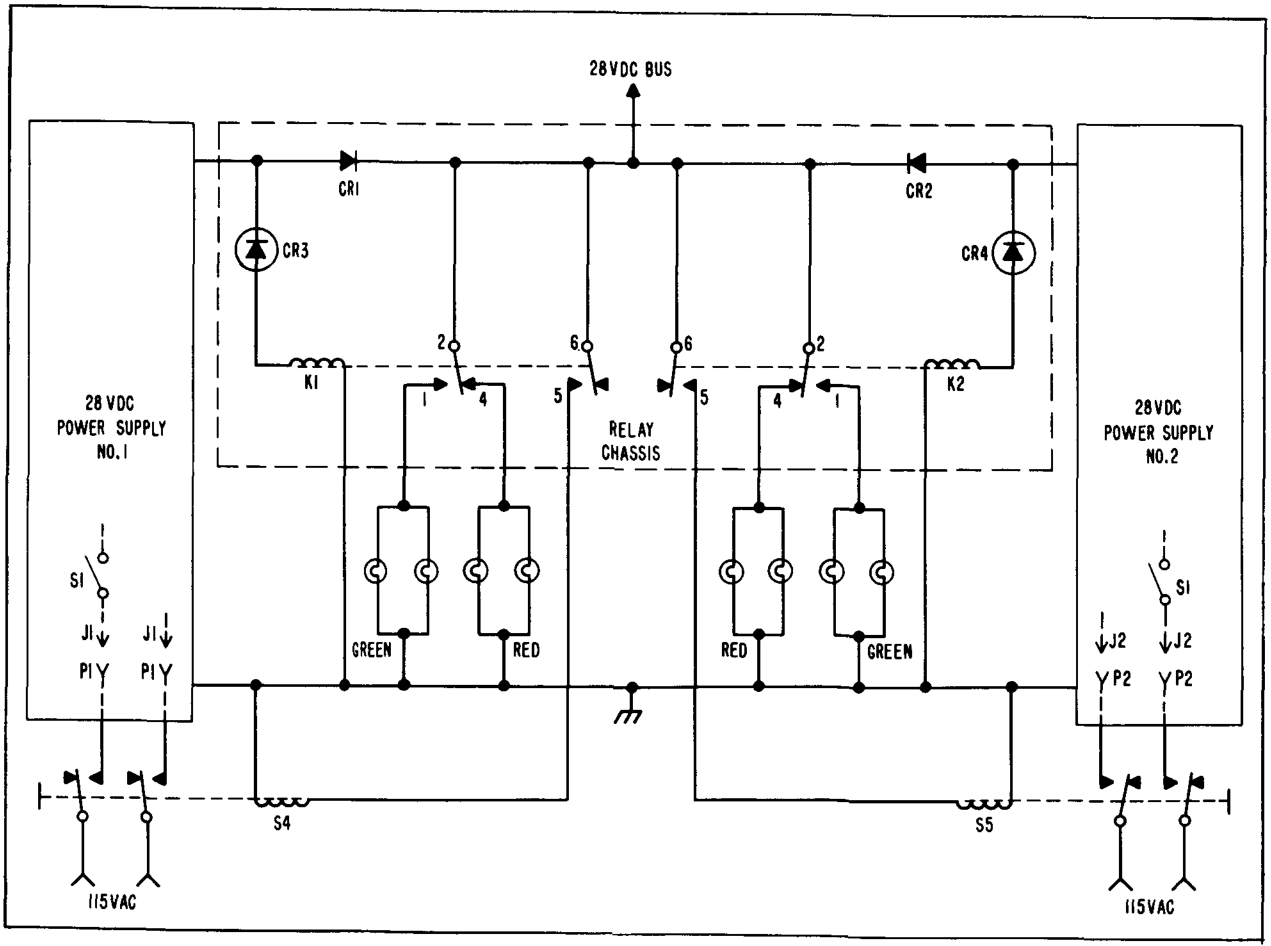


Figure 4-3. Power Supply Control Circuits, Simplified Schematic Diagram

(a). When switch S6201 on the dual power supply is closed (see figure 7-3), power is applied to power supply number 1 in the dual power supply through manually operated pushbutton switch S6004. The power supply puts 28 VDC on the bus, and relay K6001 is energized. Power is applied through K6001 contacts 5 and 6 to the coil of switch S6004, thus holding switch S6004 closed and keeping the power supply on. With relay K6001 energized, power is applied through K6001 contacts 1 and 2 to the green indicator lamps, which indicate that the power supply is on and operating properly. If power supply number 2 of the dual power supply has not yet been turned on, 28 VDC from power supply number 1 through relay K6002 contacts 2 and 4 lights the red indicator lamps associated with power supply number 2, indicating that it is not on. Rectifier CR6002 prevents current from power supply number 1 from circulating through power supply number 2 and from energizing relay K6002 when power supply number 2 is not on.

Note

> The indicator lamps associated with power supply number 1 are in the same unit as switch S6004; the lamps associated with power supply number 2 are in the same unit as switch S6005.

(b). Zener diode CR6003 in series with the coil of relay K6001 provides a sharp pull-in and drop out of relay K6001 as the voltage output of power supply number 1 increases or decreases. This action prevents the output of power supply number 1 from being applied to the console 28 VDC bus until it reaches operating value, and in the case of a malfunction resulting in low voltage, disconnects the power supply from the bus. When power supply number 1 is turned on, its voltage output begins to rise. Until the output reaches 18 volts, the resistance of CR6003 is very high, and virtually no current flows through CR6003 and the coil of K6001. As the power supply output increases above 18 volts, the resistance of CR6003 decreases, and rapidly increasing current flows through CR6003 and K6001. (The distinguishing characteristic of zener diodes is that with applied voltages above the diode reference value, 18 volts in this case, and below the maximum rated value, the resistance of the diode varies inversely with the applied voltage; current through the diode varies greatly, but the voltage drop across it remains practically constant. The action of the diode is thus like that of a VR tube.) When the supply voltage reaches approximately 22.5 volts, sufficient current flows (4.5 milliamperes) to energize relay K6001. Since the resistance of the relay coil is 1000 ohms, the values of voltage and current in the circuit at this point are as follows:

Total applied voltage	22.5 VDC
Voltage drop across CR6003	18 VDC
Voltage drop across K6001 coil.	4.5 VDC
Current $\left(\frac{4.5}{1000}\right)$	4.5 MA

As the power supply output continues to increase, the voltage drop across CR6003 remains at approximately 18 volts, the current through the circuit increases to about 10 milliamperes, and the voltage drop across the K6001 coil increases to about 10 volts.

(c). If a malfunction develops such that the output voltage of power supply number 1 begins to drop, relay K6001 will drop out sharply at an output voltage of about 22.5 volts. This action is due to the sharp increase in the resistance of zener diode CR6003 as the voltage across it drops to 18 volts. (As explained in the previous paragraph, with an output from the power supply of 22.5 volts, 4.5 volts appear across the coil of relay K6001, and 18 volts across diode CR6003.) Blocking diode CR6001 prevents current from power supply number 2 from flowing through diode CR6003 and relay K6001. When relay K6001 is de-energized, the holding coil circuit of switch S6004 is opened (by the opening of K6001 contacts 5 and 6), and primary power is disconnected from power supply number 1.

Note

In the preceding and following discussions the values of voltage, current and resistance given are for purposes of explanation. Actual circuit values vary slightly from those given. For instance, 4.5 milliamperes is the maximum current (per manufacturer's data) which is required for pull-in of relays of the type employed in the control circuit (K6001). The pull-in current for individual relays, however, varies downward from this value. Also, the drop-out current of any individual relay is of course less than the pull-in current. Hence, relay K6001 may be expected to pull in at a total applied voltage somewhat less than 22.5 VDC and to drop out at a still lower voltage.

(d). The action of the control circuit of power supply number 2 is identical to that of the control circuit of power supply number 1.

(e). A summary of the action of the power supply control circuits is as follows:

1. Switch S6004 is manually closed, and primary power is applied to power supply number 1 (assuming that switch S6201 on the dual power supply has been closed).

2. Power supply number 1 puts 28 VDC on the bus, energizing relay K6001 and lighting the red indicator lamps in the control circuit of power supply number 2.

3. Relay K6001 closes, lighting the green indicator lamp associated with power supply number 1 and applying power to the holding coil of switch S6004.

4. Switch S6004 remains closed, and power supply number 1 is in operation.

5. Switch S6005 is closed, and primary power is applied to power supply number 2.

6. Power supply number 2 puts 28 VDC on the bus, in parallel with the power from power supply number 1.

7. Relay K6002 is energized, turning off the red indicator lamps associated with power supply number 2 and lighting the green indicator lamps. Power is applied through K6002 contacts to the holding coil of switch S6005, holding S6005 in the on position. Both power supplies are now in operation.

8. Both power supplies are turned off by opening switch S6201 on the dual power supply.

9. If the voltage output of one of the power supplies drops to approximately 22.5 volts, the control relay (K6001 or K6002) associated with the malfunctioning power supply is de-energized and the primary power to that power supply is removed. Power from the other power supply lights the red indicator lamps of the malfunctioning supply. The ratings of the power supplies are such that one of them can supply all of the power required by the console in the event of the failure of the other.

(3). SWITCHES AND INDICATORS

(a). A number of switch assemblies and indicator assemblies are used on the acquisition data panel of the acquisition data console. An exploded view of the type of switch assembly used is shown in figure 4-4. The assembly consists of two, main detachable sections: the switch and the operator-indicator unit with coil. The switch has up to four single-pole, double-throw sections. All of the switch sections are actuated simultaneously by a plunger in the operator-indicator unit. The operator-indicator unit has two, main, non-detachable sections: the coil and the indicator. When energized, the coil holds the plunger in its actuated position. The indicator has four lamp sockets, lamps, color filters, and a three-piece display screen. The lamps are white, so the colored lighting of the indicator is obtained by the use of filters which fit over the lamps. The display screen snaps into the end of the indicator plunger when the indicator is

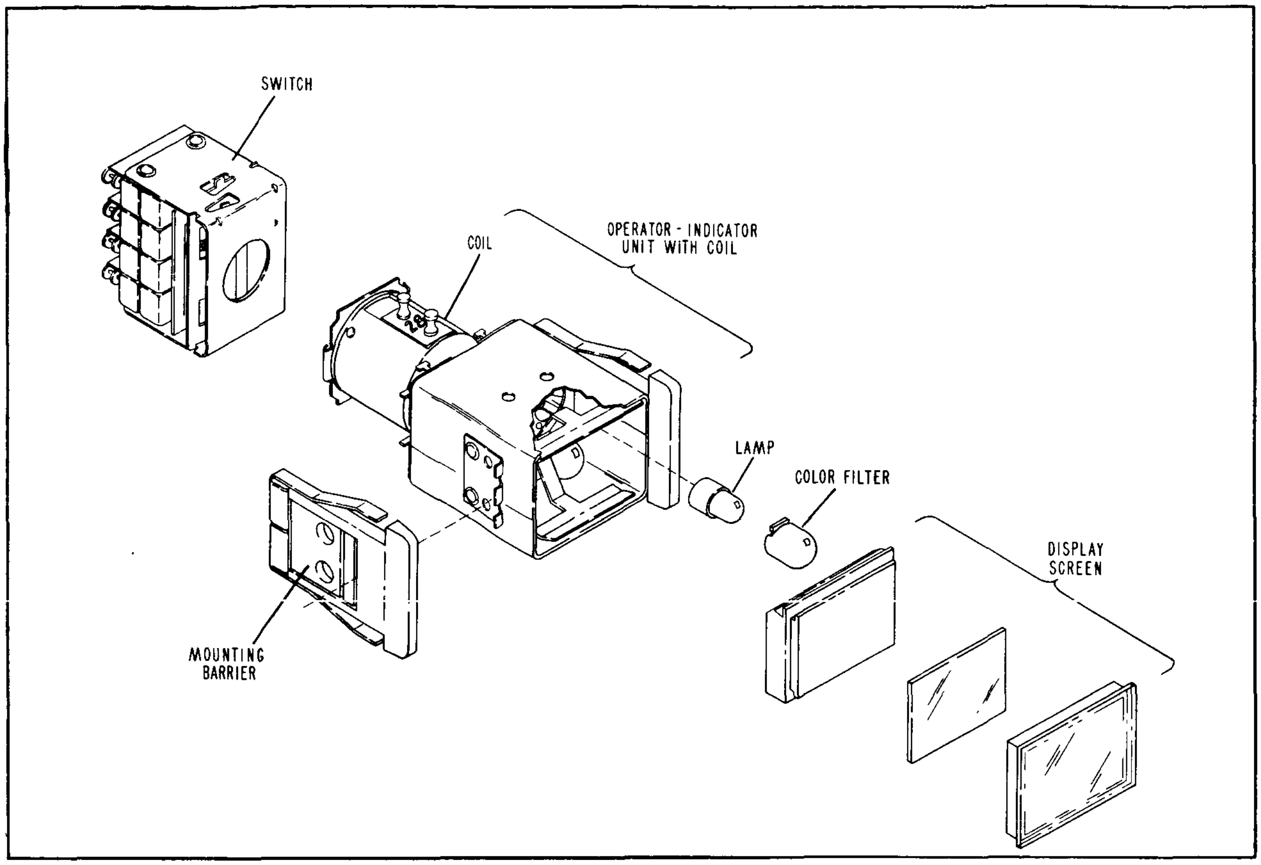


Figure 4-4. Switch Assembly, Exploded View

assembled, so that the plunger is moved and the switch actuated by depressing the display screen.

(b). The indicator assemblies used on the console are like the operator-indicator unit shown on figure 4-4, except that the indicator assemblies have no coil and no plunger.

(4). CIRCUIT DESCRIPTION (Figure 7-1)

This paragraph gives a detailed description of the circuits of the acquisition data console except for the power supply, which is described in a previous paragraph, and the synchro line amplifier, which is covered in paragraph 4-2.C. below.

(a). D-C INDICATIONS

The application of power to the synchro remoting system and the operating modes of CADDAC, the TLM-18, and the transmitting antenna are indicated by lamps on the acquisition data console. Some of these lamps are supplied with 28 VDC from the console power supply, with ground supplied through switches in the external equipment; others are connected to ground in the console, with 28 VDC supplied through switches in the external equipment. For instance, when the TLM-18 is tracking automatically, the TLM-18 operator closes a switching circuit which connects ground to terminal 5 of terminal board TB6011 in the console, thus lighting TLM-18 "VALID TRACK" indicators DS6001 and DS6002. Other operating mode indicators on the console are as follows:

1. Manual tracking by the TLM-18 is indicated by the lighting of TLM-18 "MANUAL" indicators DS6005 and DS6006. One side of these indicators is connected to 28 VDC in the console, and ground is applied to the other side through TLM-18 mode switching and terminal 6 of terminal board TB6011.

2. The operating mode of the voice and command transmitting antenna is indicated by "SLAVED" indicators DS6017 and DS6018 and "MANUAL" indicators DS6019 and DS6020. The application of ground to these indicators is controlled by the transmitting antenna mode ("LOCAL-REMOTE") switches.

3. The two channels, azimuth and elevation, of the voice and command transmitting antenna drive system are independent of one another to the extent that either channel can be operated in the slaved or manual mode while the other channel is operated in the other mode. The "LOCAL-REMOTE" (mode) switches of the antenna are connected to the operating mode indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified form on

figure 4-5. From the illustration it can be seen that when both the azimuth and elevation "LOCAL-REMOTE" switches are in the "REMOTE" (slaved) position, 28 VDC is applied to "SLAVED" indicator on the acquisition data console; when either "LOCAL-REMOTE" switch is in the "LOCAL" (manual) position, 28 VDC is applied to the "MANUAL" indicator on the console.

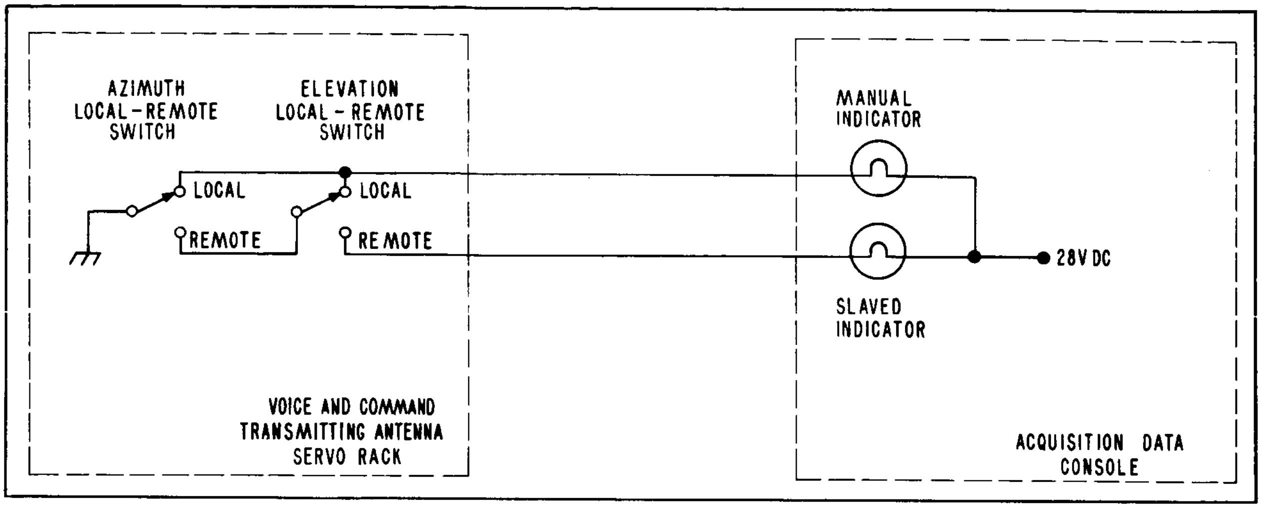


Figure 4-5. Voice and Command Transmitting Antenna Mode Indication Circuit, Simplified Schematic Diagram

4. The complete mode indicating circuit of the voice and command transmitting antenna is shown on figure 7-10. Note that the mode indicators on the acquisition data console are not actually operated directly by the switches in the transmitting antenna, but rather are operated by relay K6008, which is controlled by the transmitting antenna switches. With K6008 unenergized, ground is applied to the lamps in the "SLAVED" indicator, thus lighting these lamps. When K6008 is energized, ground is applied through K6008 contacts to the lamps in the "MANUAL" indicator, and they are lit. It can be seen from figure 7-10 that transmitting antenna "LOCAL-REMOTE" switches S101 and S102 are so wired that they perform the function described in the previous paragraph. When either of them is in the "LOCAL" position, ground is connected to relay K6008 in the acquisition data console and it is energized,

producing a "MANUAL" indication on the console. Only when both S101 and S102 are in the "REMOTE" position is K6008 de-energized and a "SLAVED" indication given on the console. J6013 in the relay coil circuit provides a convenient place for measuring current to adjust potentiometer R6004 for proper operation of the relay.

5. The voice and command transmitting antenna can rotate 540 degrees in azimuth from its clockwise to its counterclockwise limit. Since it can rotate more than 360 degrees, there are azimuths at which the synchro display alone is ambiguous; i.e., the synchro display shows the azimuth of the antenna, but does not show whether it is on its first or second time around. Since the antenna cannot rotate continuously, it is necessary to know where it is relative to its limits of rotation so that the operator can position it for maximum freedom of rotation in either direction and can avoid driving it into its limit stops. The ambiguity of the synchro display is resolved by the use of cable wrap indicator lamps DS6035 and DS6036, which are lit by the closing of a switch on the antenna pedestal. This switch is so located that it is actuated when the antenna passes the midpoint between its azimuth limits. The DS6035 circuit is closed and the DS6036 circuit opened when the antenna is rotating clockwise (looking at it from above); the DS6036 circuit is closed and the DS6035 circuit opened when the antenna is rotating counterclockwise. At installation the antenna is so oriented that the counterclockwise limit is reached at zero degrees (relative to north) and the clockwise limit at 180 degrees. (See figure 4-6.) With this orientation, the cable wrap indicator switching occurs at 270 degrees. Figure 4-7 illustrates how the cable wrap indicator lamps and the antenna azimuth display synchro together show the acquisition data console operator where the antenna is relative to its limits of rotation. When the upper cable wrap indicator is lit [figures 4-7(A) and 4-7(B)] , the antenna has been turned past 270 degrees in a clockwise

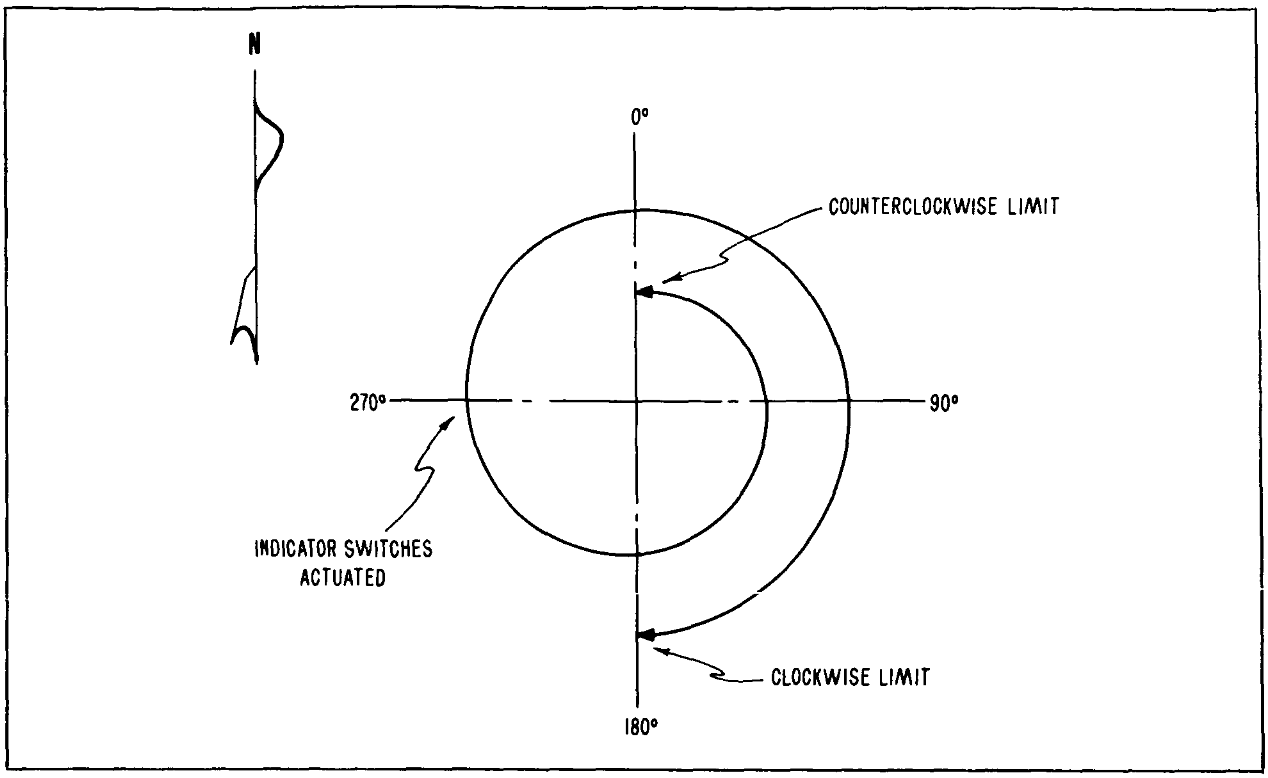


Figure 4-6. Diagram of Antenna Cable Wrap Limits

direction, and if it continues in a clockwise direction, the limit of rotation will be reached at 180 degrees azimuth. When the lower indicator is lit [figures 4-7(C) and 4-7(D)] , the antenna has been turned past 270 degrees in a counterclockwise direction, and continuing in a counterclockwise direction, the limit will be reached at zero degrees azimuth. Thus, as long as the synchro pointer is on the half of the dial (upper or lower) which is the nearer to the lighted indicator [figures 4-7(A) and 4-7(C)] , there is no limit problem and the antenna can safely be turned in either direction; when the synchro pointer is on the half of the dial opposite the lighted indicator [figures 4-7(B) and 4-7(D)] , the antenna is near one of its limits of rotation and care must be exercised not to drive it into the limit stop. The complete cable wrap circuit is shown in figure 7-10. Note that the indications on the console are operated through relays in a manner similar to the mode indicators, previously described.

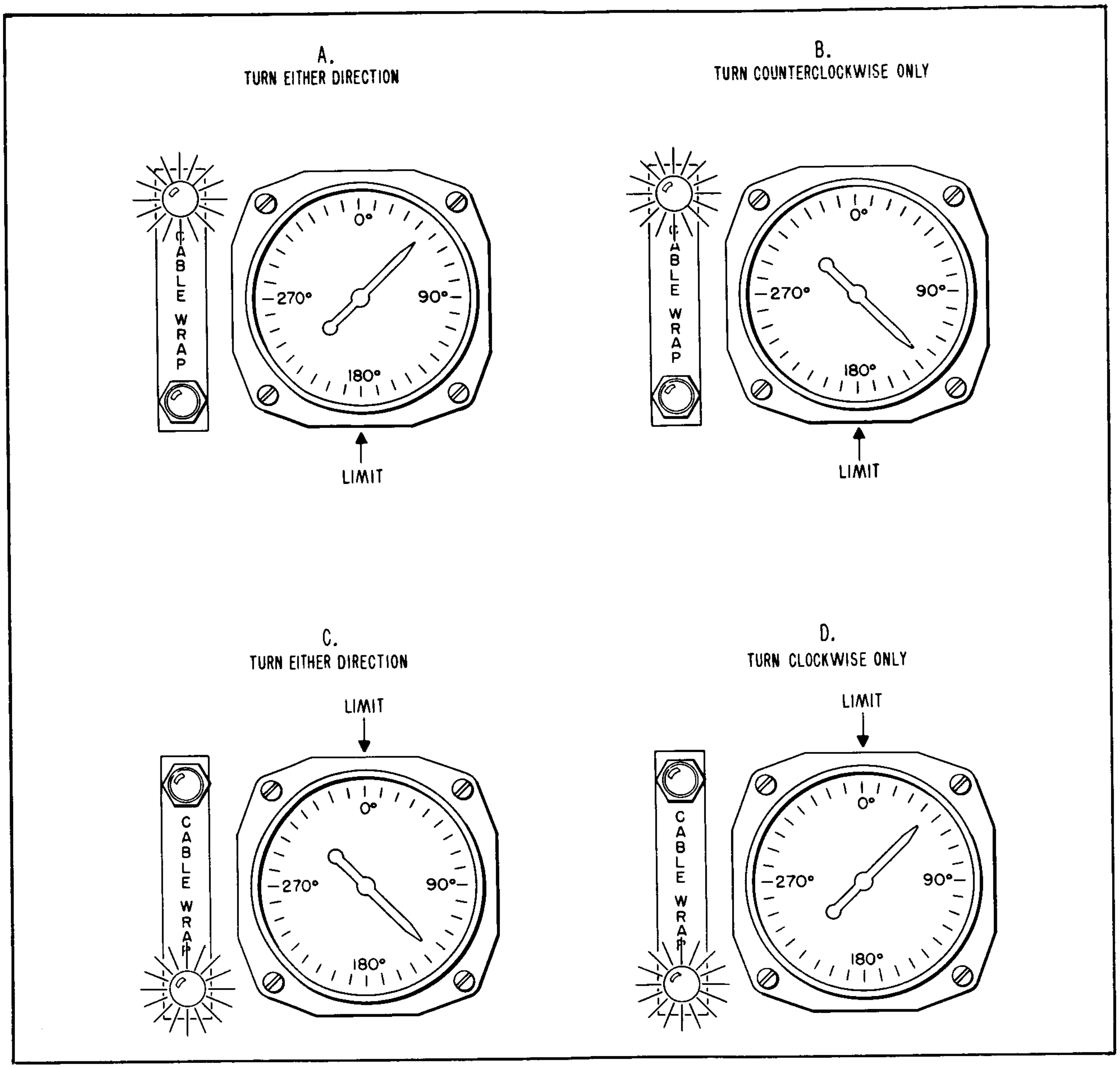


Figure 4-7. Synchro and Lamp Indications of Antenna Bearing Relative to Cable Wrap Limits

6. The operating mode of CADDAC is indicated by "VALID TRACK" indicators DS6009 and DS6010, "SLAVED" indicators DS6011 and DS6012, and "MANUAL" indicators DS6013 and DS6014 (see figure 7-1). Ground is applied to these indicators through mode switching circuits in CADDAC.

7. "DATA LINK POWER" indicators DS6025 and DS6026 are lit by the application of 28 VDC from the synchro remoting system when primary power is applied to the units of that system.

(b). SYNCHRO CIRCUITS

Not counting the two receivers in the HF antenna positioning system, there are five pairs of synchro receivers and one pair of synchro transmitters on the acquisition data console. (For a description of the principles of operation of synchros, refer to paragraph 4-2. H.) One of each pair handles azimuth data and the other elevation data. (See figure 7-1.)

1. Display data from the TLM-18 is displayed by synchro receivers B6001 and B6002. Azimuth display data comes into the console by way of terminal board TB6002 to synchro receiver B6001, and elevation data comes in by way of terminal board TB6002 to receiver B6002. TLM-18 position data comes into terminal board TB6010 and thence to the normally open contacts of relay K6005, where it is available for switching onto the acquisition bus. The interconnecting circuits are shown on figure 7-9.

2. Position data from CADDAC (specifically from the cartesian to polar coordinate converter) comes in through terminal boards TB6013 and TB6008 to relay K6003, which when energized switches this data onto the acquisition bus. There is no separate display data available from CADDAC, so the CADDAC position data is used for display on the console. Azimuth data from CADDAC is displayed on synchro receiver B6003 and elevation data on receiver B6004. See figures 7-1 and 7-8.

3. Display data from the transmitting antenna through the synchro remoting system comes into the console on terminal board TB6004 and is displayed by azimuth synchro receiver B6005 and elevation synchro receiver B6006. There is no position data from the transmitting antenna; that is, no data that is

available for switching onto the acquisition bus. See figures 7-1 and 7-7.

4. Whatever data is on the acquisition bus is displayed by acquisition bus display synchro receivers B6007 and B6008. Receiver B6007 displays azimuth data, and receiver B6008 displays elevation data. These displays make it possible for the console operator to monitor the output of the console onto the acquisition bus by comparing what is going onto the bus with the display of the source data from the manual input, the TLM-18, or CADDAC.

5. The manual input to the acquisition bus is made by means of synchro transmitters B6011 and B6012—B6012 for azimuth data and B6011 for elevation data. The output of these synchro transmitters is available at relay K6004 for switching onto the acquisition bus and is also wired directly to manual display synchro receivers B6010 (azimuth) and B6009 (elevation). Note that the S1-S3 connections from the manual synchro transmitters to the manual display receivers and to the acquisition bus are reversed. This reversed connection is necessary to obtain the proper output from the manual synchro transmitters because of a direction reversal that occurs in the gearing between the transmitter handwheels and the transmitters. To set data into the manual synchro transmitters, the console operator turns the transmitter handwheels and observes the manual receiver displays. There are no dials on the handwheels or the transmitters themselves to indicate the position of the transmitters.

(c). DATA SWITCHING

The switching of data onto the acquisition bus from one of the three available sources (manual input, TLM-18, and CADDAC) is controlled by switches S6001, S6002, and S6003 (figure 7-1). These switches (and switches S6004 and S6005 associated with the 28 VDC power supply) are switch assemblies of the type described in paragraph 4-2.B.(3)., and illustrated in figure 4-4.

1. Switch S6001 is the TLM-18 "SOURCE" switch. When the plunger of S6001 is depressed, 28 VDC from the d-c bus is applied through the common and normally open contacts of section S6001A to the switch holding coil and through the common and normally open contacts of section S6001B to indicator lamps DS6007 and DS6008. The lamps are lit, and the holding coil, which is grounded through the common and normally closed contacts of section D of switch S6002 and section C of switch S6003, is energized. The action of the coil holds the plunger of S6001 in its depressed position. The common and normally closed contacts of section S6001A are in series with the 28 VDC supply to switches S6002 and S6003; thus, when the plunger of S6001 is depressed, the 28 VDC supply to S6002 and S6003 is interrupted and if either of these switches had been energized, it is now de-energized. With switch S6001 closed (plunger-depressed), 28 VDC is supplied through the common and normally open contacts of section S6001C to the coil of relay K6005, energizing this relay and connecting position data from the TLM-18 to the acquisition bus.

2. Switch S6002 is the CADDAC "SOURCE" switch. When the plunger of this switch is depressed, the common and normally closed contacts of section S6002D are opened, thus breaking the circuit of the holding coil of switch S6001. If switch S6001 had been energized, it is now de-energized, and 28 VDC is applied through the common to the normally open contacts of sections A and B of S6002. Twenty-eight volts d-c on the normally open contact of S6002A is applied to the holding coil of S6002 and to the coil of relay K6003. The 28 VDC on the normally open contact of S6002B is applied to indicating lamps DS6015 and DS6016. The coil of S6002 is grounded through section C of switch S6003; when energized it holds the plunger of S6002 in the actuated position. With 28 VDC on the normally open contact of section S6002B, indicator lamps DS6015 and DS6016 are lit, and with 28 VDC on the normally open contact

of section S6002A, relay K6003 is energized, connecting position data from CADDAC to the acquisition bus. The common and normally closed contacts of section S6002A are in series with the 28 VDC supply to switch S6003, so that when S6002 is actuated, the 28 VDC supply to switch S6003 is interrupted. The common and normally closed contacts of section C of S6002 are in series with slaving control circuits in CADDAC. When S6002 is actuated, CADDAC (and the radars connected to it) cannot be slaved to the data on the acquisition bus. This arrangement prevents CADDAC from being slaved to data for which it is the source.

3. Switch S6003 is the manual "SOURCE" switch. Section S6003C is in series with the holding coils of switches S6001 and S6002; when S6003 is actuated (plunger depressed), the holding coil circuits of S6001 and S6002 are opened, de-energizing whichever (if either) of these switches had been energized. Twenty-eight volts d-c is applied to the normally open contact of section S6003A and thence to the holding coil of S6003 and to the coil of relay K6004. Twenty-eight volts d-c is also applied through the normally open contact of section S6003B to indicating lamps DS6023 and DS6024. The 28 VDC on the coil of relay K6004 energizes that relay, and data from the manual input is connected to the acquisition bus. The 28 VDC applied to the holding coil of S6003 energizes the coil and holds the switch plunger in the actuated position. The indicator lamps are lit, showing the data source which has been selected.

4. "NO DATA ON BUS" indicator lamps DS6021 and DS6022 are supplied with 28 VDC in series with the common and normally closed contacts of the A sections of switches S6001, S6002, and S6003. The indicator lamps are lit as long as the console 28 VDC power supply is on and none of the three switches has been actuated; when any one of the switches, S6001, S6002, and S6003, is actuated, the "NO DATA ON BUS" indicator lamps are out.

5. As described in the preceding paragraphs, switches S6001 through S6003 are electrically interlocked; when any one of them is actuated by depressing the plunger, d-c power to the coils of all the others is interrupted. If two or more are actuated at the same time (which should never happen), they open each other's circuits; neither holding coil is energized, and only the one electrically nearer the 28 VDC supply connects data to the bus. For example, if S6001 and S6003 both happened to be depressed at the same time, the depressing of S6003 would have no effect since the 28 VDC to it would be interrupted by the depressing of S6001. Since 28 VDC would be applied to S6001, relay K6005 would be energized and data from the TLM-18 would be put on the acquisition bus. However, the holding coil circuit of S6001 would be opened by the depressing of S6003, and S6001 would not remain depressed when it was released.

6. When the dual power supply on the console is first turned on, none of the "SOURCE" switches is actuated. After any one of them has been actuated, or turned on, they can all be de-energized, or turned off, only by turning off the dual power supply with switch S6201 (on the front of the dual power supply panel).

C. SYNCHRO LINE AMPLIFIER

A block diagram of the synchro line amplifier and the manner in which it is connected into the system is shown in figure 4-8. The azimuth and elevation synchro transmitters shown on the illustration represent the transmitters at whatever source (manual input, CADDAC, or TLM-18) has been connected to the acquisition bus. The azimuth and elevation receivers on the illustration represent the receivers in the TLM-18 and the console acquisition bus display receivers. (The receivers in the TLM-18 and those in console bus display are in parallel.) In both the azimuth and elevation channels, which are identical, the S2 stator windings are directly connected. The S1-S2 stator voltage and the S2-S3 stator voltage are amplified by amplifier elements with the S2 winding being the common (chassis ground) connection in both cases. Each amplifier element consists of a voltage amplifier, a phase splitter, a push-pull cathode follower driver, and a push-pull power amplifier. With this arrangement, a third amplifier element is not necessary for the S1-S3 voltage; the S1-S3 voltage is taken across the output of the two amplifier elements. The output of the amplifier elements in the synchro line amplifier is reversed 180 degrees in phase from the input. To compensate for this reversal, the receiver rotors are zeroed at 180 degrees. (Refer to paragraph 5-4.B.) For a complete discussion of the theory of operation of the synchro line amplifier, refer to the applicable equipment manual.

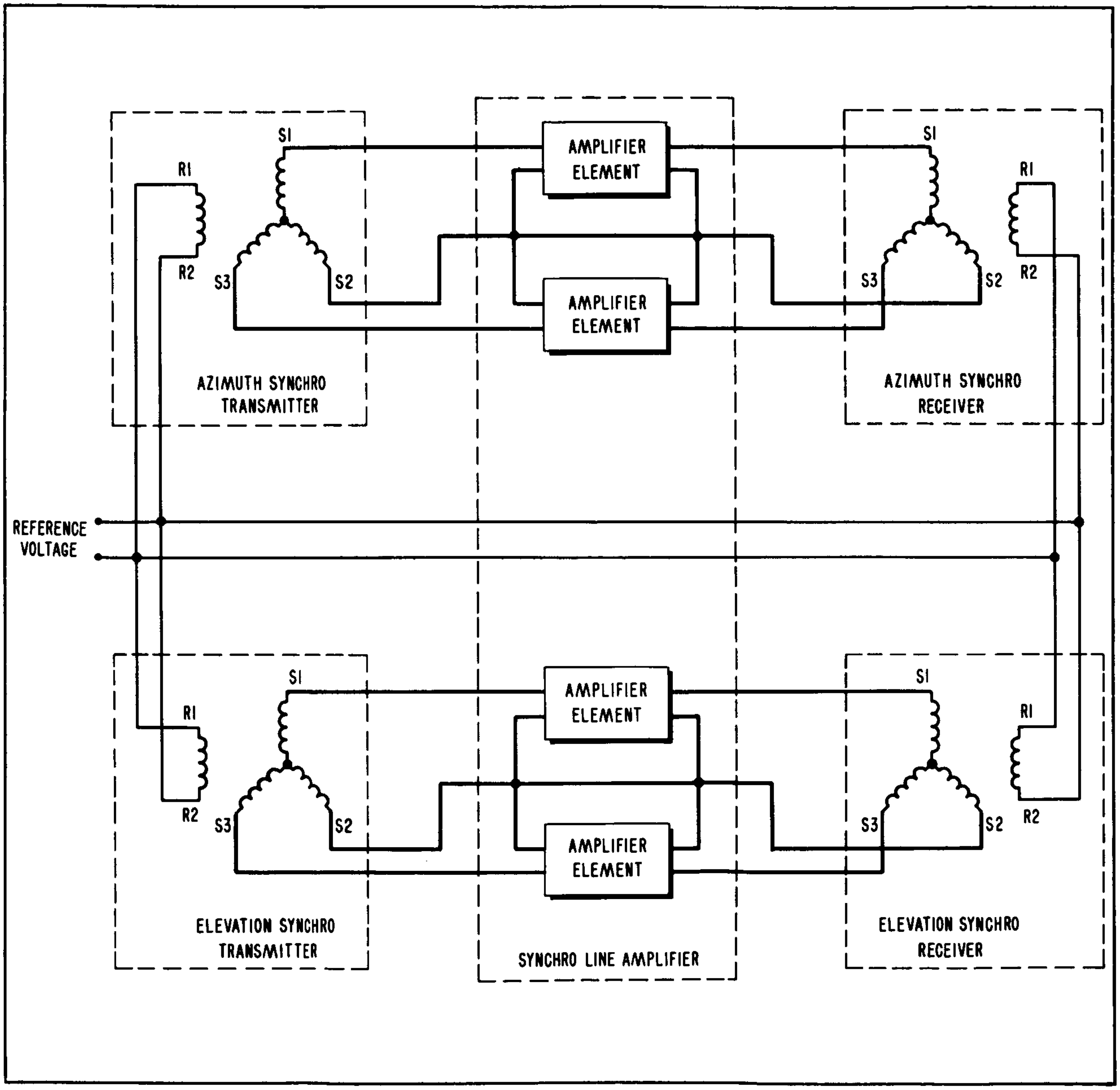


Figure 4-8. Synchro Line Amplifier, Block Diagram

D. SYNCHRO REMOTING SYSTEM

As was discussed in Section I and in previous paragraphs in this section, the complete synchro remoting system consists of two virtually identical transmitters and three virtually identical receivers. Each of the transmitters and receivers has two channels, one for azimuth data and the other for elevation data. Each channel of the system converts synchro data into a 10-bit digital code (gray code) using frequency-multiplexed audio tones, transmits the encoded data over a voice-quality telephone line (3-KC bandwidth), and at the receiving end decodes the transmitted signal and synthesizes a synchro signal. A block diagram of one transmitter channel and one receiver channel of the system is shown in figure 4-9. A servo loop consisting of a control transformer, a servo amplifier and a servo motor, positions the shaft of the

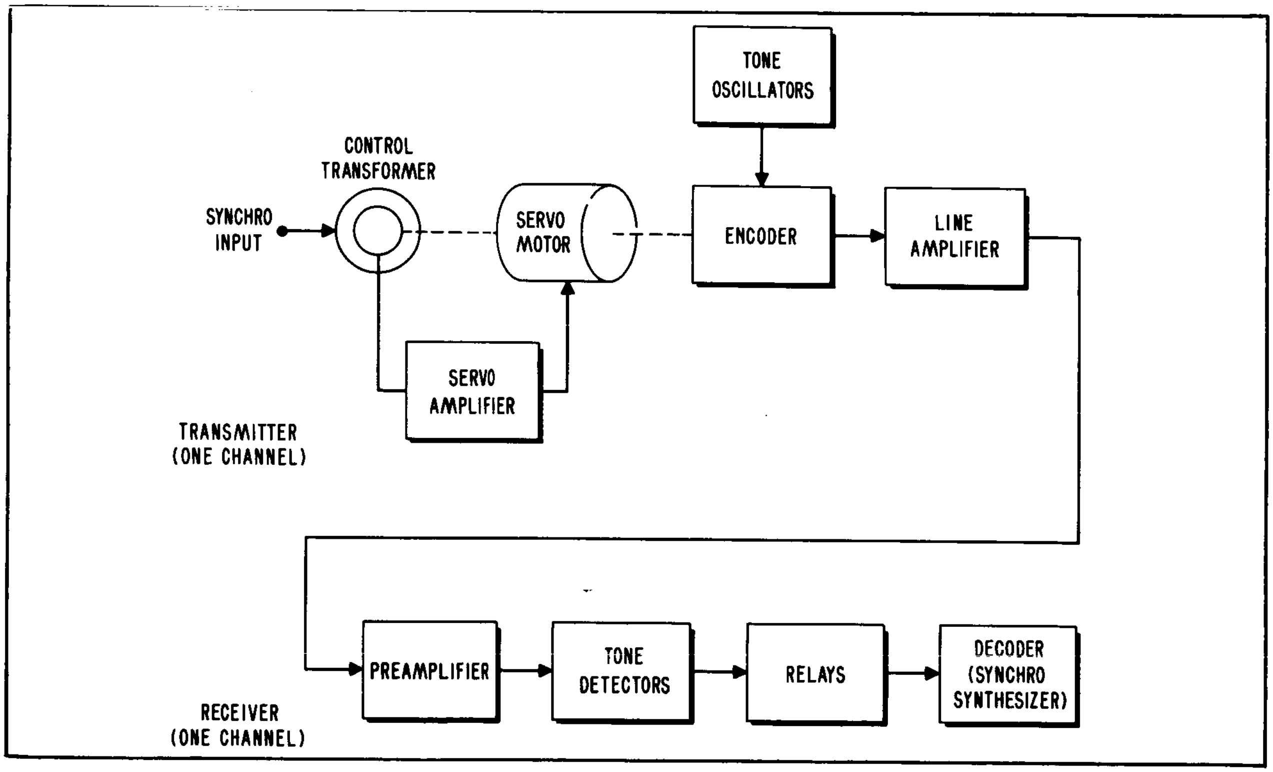


Figure 4-9. Synchro Remoting System, Block Diagram

digital encoder in accordance with the synchro data input to the channel. (For a discussion of the principles of such a servo loop, refer to paragraph 4-2.I.) Ten tone oscillators, which have frequencies spaced 200 CPS apart from 1100 to 2900 CPS, are connected to wipers on the encoder. The encoder connects combinations of the ten tones to a common line in accordance with a digital code which represents the angle of the encoder shaft. The composite-tone (multiplexed) output of the encoder is amplified and transmitted to the receiver. The received signal is amplified by a preamplifier and supplied to ten tone detectors. Each of the detectors consists of an LC filter and two amplifier stages. The filter in each of the detectors is tuned to one of the audio frequencies used by the system. Each detector produces an output only when the tone, or frequency, to which its filter is tuned is present in the composite received signal. Each detector is connected to a relay, which is energized when the detector produces an output. Each of the ten relays is thus energized or not energized in accordance with the on or off condition of the corresponding wiper in the transmitter encoder; hence, when considered together, the relay contacts by their open or closed condition contain a digital representation of the synchro input to the transmitter. The decoder consists of a special transformer with multiple windings. The ten relays connect combinations of the transformer windings to produce a synthesized synchro signal which, within the limitation of system accuracy, is the same as the synchro signal supplied to the system transmitter. For a complete discussion of the theory of operation of the synchro remoting system, refer to the applicable equipment manual.

E. <u>18-64 SYNCHRO SPEED CONVERTER</u>

A block diagram of the 18-64 synchro speed converter is shown in figure 4-10. Synchro data from the elevation channel of the synchro remoting system two-channel receiver is applied to the control transformer of a servo loop consisting of a control transformer, a servo amplifier and a servo motor. (For a discussion of the principles of such a servo loop, refer to paragraph 4-2.I.). Through a gear train which has a gear step-up ratio of 18:64, the servo motor drives a synchro transmitter whose output is supplied through CADDAC to the elevation drive channel of the Mod II radar. Thus, for every 18-degree change in angle of the input to the converter, the output changes 64 degrees. This synchro speed step-up is necessary to compensate for a 64:18 speed step-down in the elevation drive channel of the Mod II radar. For a detailed discussion of the theory of operation of the 18-64 synchro speed converter, refer to the applicable equipment manual.

F. <u>TLM-18</u>

For information on the theory of operation of the TLM-18, refer to the applicable equipment manual. The acquisition bus display panel on the TLM-18

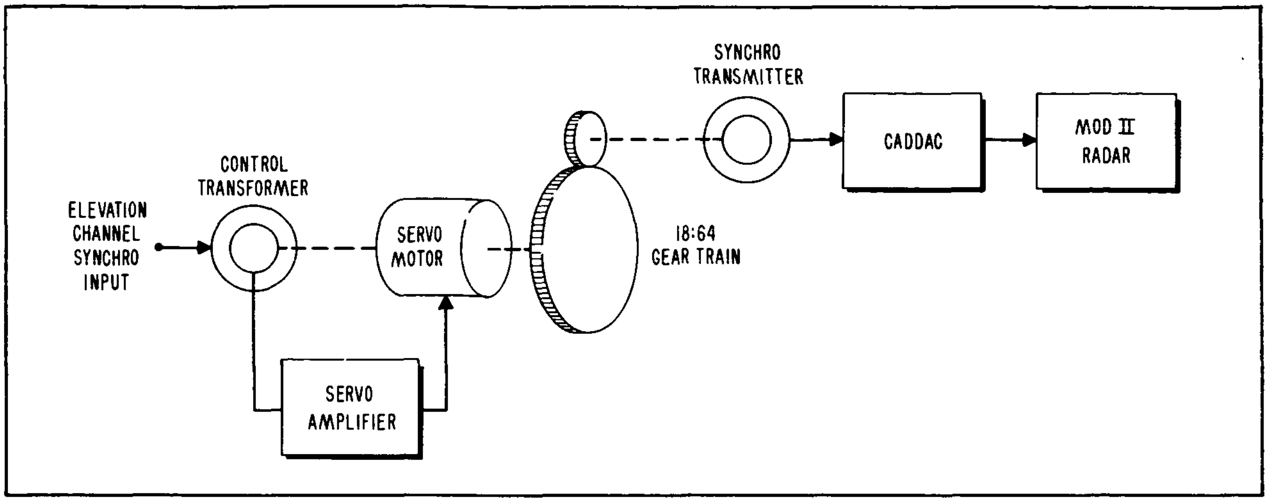


Figure 4-10. 18-64 Synchro Speed Converter, Block Diagram

consists simply of two synchro receivers, one to display azimuth data and the other to display elevation data from the acquisition bus. See figure 7-5.

G. HF ANTENNA POSITIONING SYSTEM

(1). The parts of the HF antenna positioning system which are on the acquisition data console are shown on figures 7-1 and 7-2. A schematic of the complete HF antenna positioning system is shown on figure 7-6. Its function is to provide a means of remote, manual positioning in azimuth of the two HF voice receiving antennas on the site. As shown on figure 7-6, each of the two antennas is driven in azimuth by a 2-phase motor in the antenna rotator unit. The direction of rotation of the motor is determined by the position of a switch, S6006 or S6007, on the acquisition data console. When the switch is in the center position, no power is applied to the drive motor and the antenna remains stationary. In order that the operator at the acquisition data console may know the azimuth position of each antenna, a synchro indicating system is used. A synchro transmitter is mechanically coupled to each antenna mast, and a synchro receiver (B6013 and B6014) on the acquisition data console is connected to each of the synchro transmitters. Thus the azimuth position of each antenna is displayed on the acquisition data console.

(2). It should be noted that the HF antenna positioning system synchro circuits differ in several respects from the acquisition system circuits: The HF antenna positioning system synchros require 32 VAC rotor voltage instead of the 115 VAC employed by the acquisition system synchros. This 32 VAC is obtained from transformers T6001 and T6002 on the acquisition data console. (See figure 7-6.) Also, as shown on figure 7-6, all of the connections between the transmitters and receivers are crossed; S1, S2, and S3 of the receivers are connected respectively to S2, S3, and S1 of the transmitters. The "error" introduced by this method of connection is compensated for by introducing an equal and opposite error in alignment between each transmitter and receiver unit.

H. SYNCHROS

(1). TRANSMITTERS AND RECEIVERS

(a). A standard synchro transmitter or receiver, such as is used in the acquisition system, may be considered as a single-phase transformer with a rotatable primary and a stationary, wye-wound secondary. Accordingly, the primary winding is called the rotor, and the secondary windings are called the stator. The two terminals of the rotor windings are designated R1 and R2, and the terminals of the three stator windings are designated S1, S2, and S3.

(b). A reference, or excitation voltage (115 VAC, 60 cycles for the synchros in the acquisition system) is applied to the rotor of a synchro. (See figure 4-11.) This reference voltage applied to the rotor of the

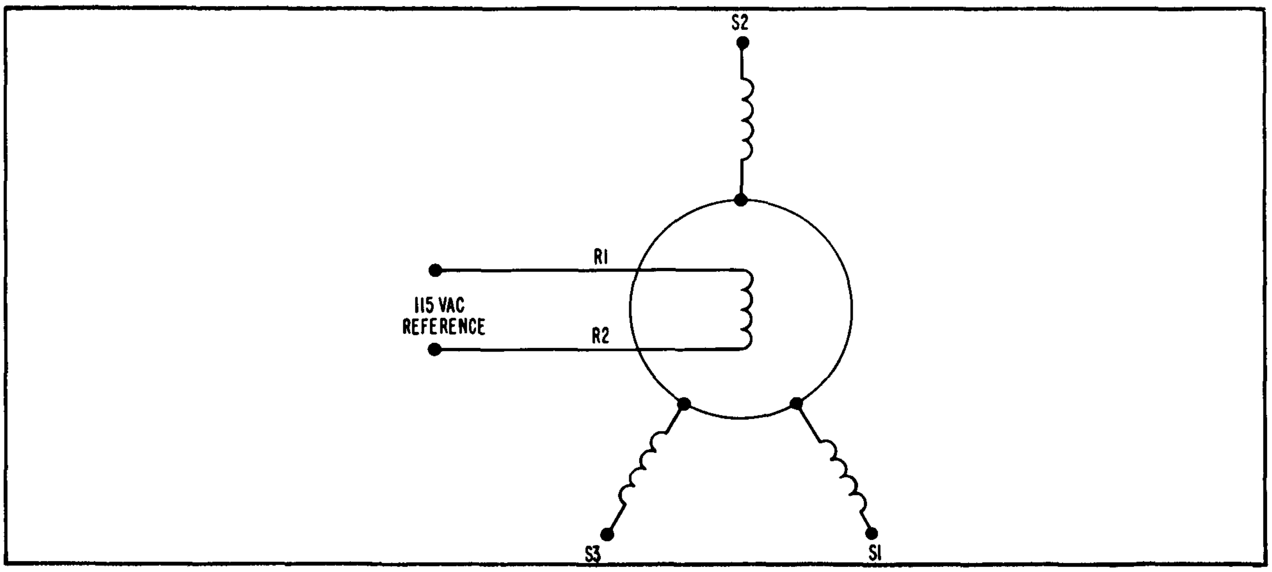


Figure 4-11. Synchro Transmitter or Receiver, Schematic Diagram

synchro induces voltages in the stator windings. The magnitude of the voltage induced in a given stator winding depends on the angle which the rotor makes with that stator winding, and the phase angle of the voltage in a stator winding with respect to the rotor voltage is always zero or 180 degrees. The voltages in the windings of a synchro stator are shown in figure 4-12. The curves in the illustration are plots of the voltage magnitudes and phase against the angle of the rotor. The voltage across each stator winding (i. e. , from the winding terminal to the common connection of the three windings) varies from 52 VAC (rms) of one phase polarity through zero to 52 VAC of the opposite phase polarity as the rotor is turned. Due to the way the rotor and stator windings are arranged on a synchro, these curves are sinusoidal. However, they should not be confused with time graphs of sinusoidal voltages. All of the voltages in a synchro system are a-c, they are either in phase or 180 degrees out of phase with each other, and their effective (rms) values vary as shown on the illustration with the angle of the rotor.

(c). In practice, no external connection is made to the common connection of the three stator windings, and the synchro system stator voltages are taken between the three pairs of windings; S2 and S1, S2 and S3, and S1 and S3. The voltage magnitude and phase between these pairs of windings is shown in figure 4-13 for varying rotor angles.

(d). The simplest form of synchro system consists of a transmitter and a receiver. A transmitter and a receiver which are suitable for use in the same system generally are electrically identical, but differ somewhat mechanically. The most notable mechanical difference is the use of a damper on the receiver in order to prevent it from oscillating. The transmitter, being mechanically coupled to an antenna or handwheel through a gear train requires no damper. Hence, if mechanical coupling can be arranged, a receiver can be used as a transmitter, but a transmitter generally cannot be used as a receiver.

(e). The manner in which a synchro system works is illustrated in figures 4-14 and 4-15. The stator windings of the transmitter are connected to the corresponding windings on the receiver; S1 to S1,

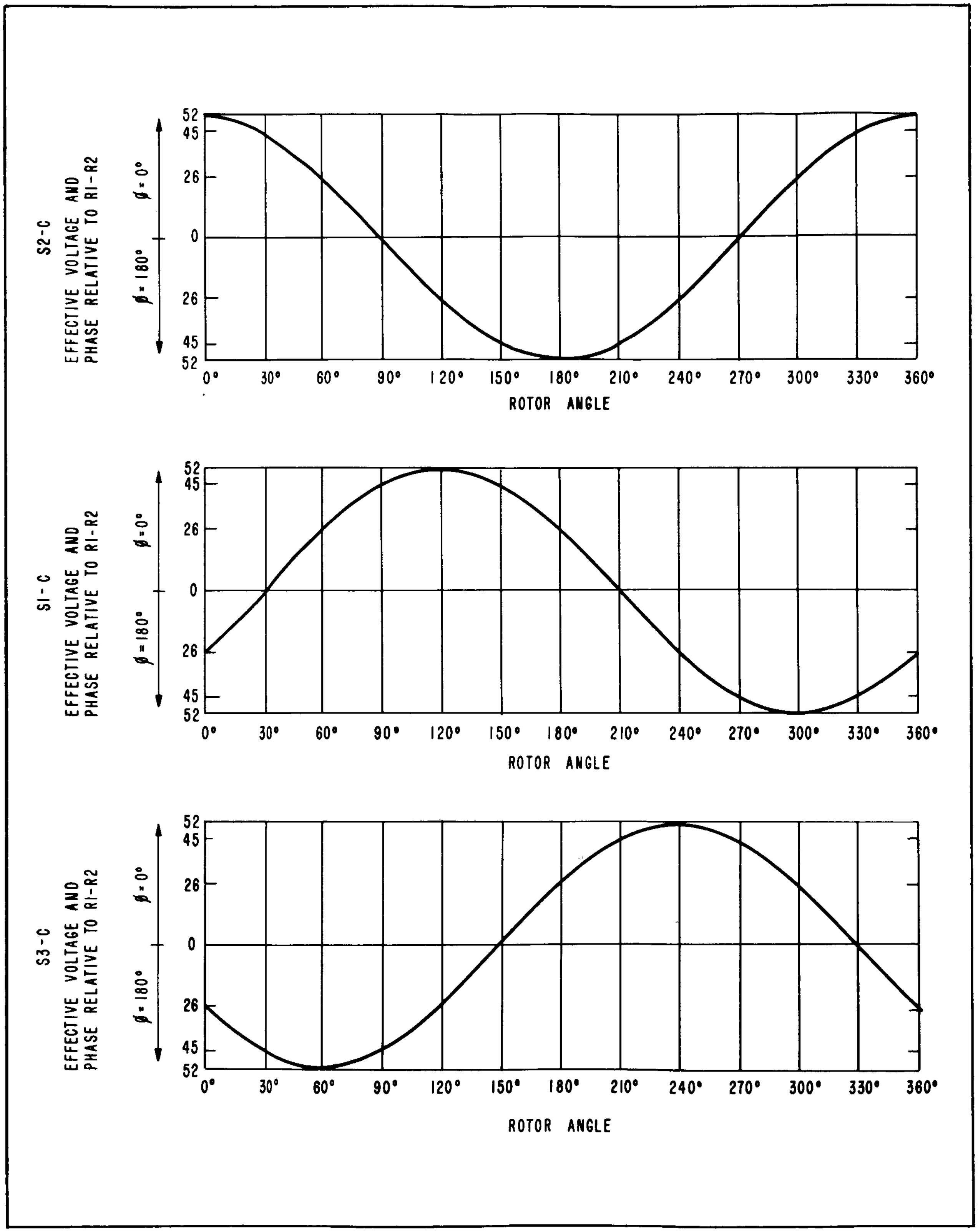


Figure 4-12. Voltages in Synchro Stator Windings

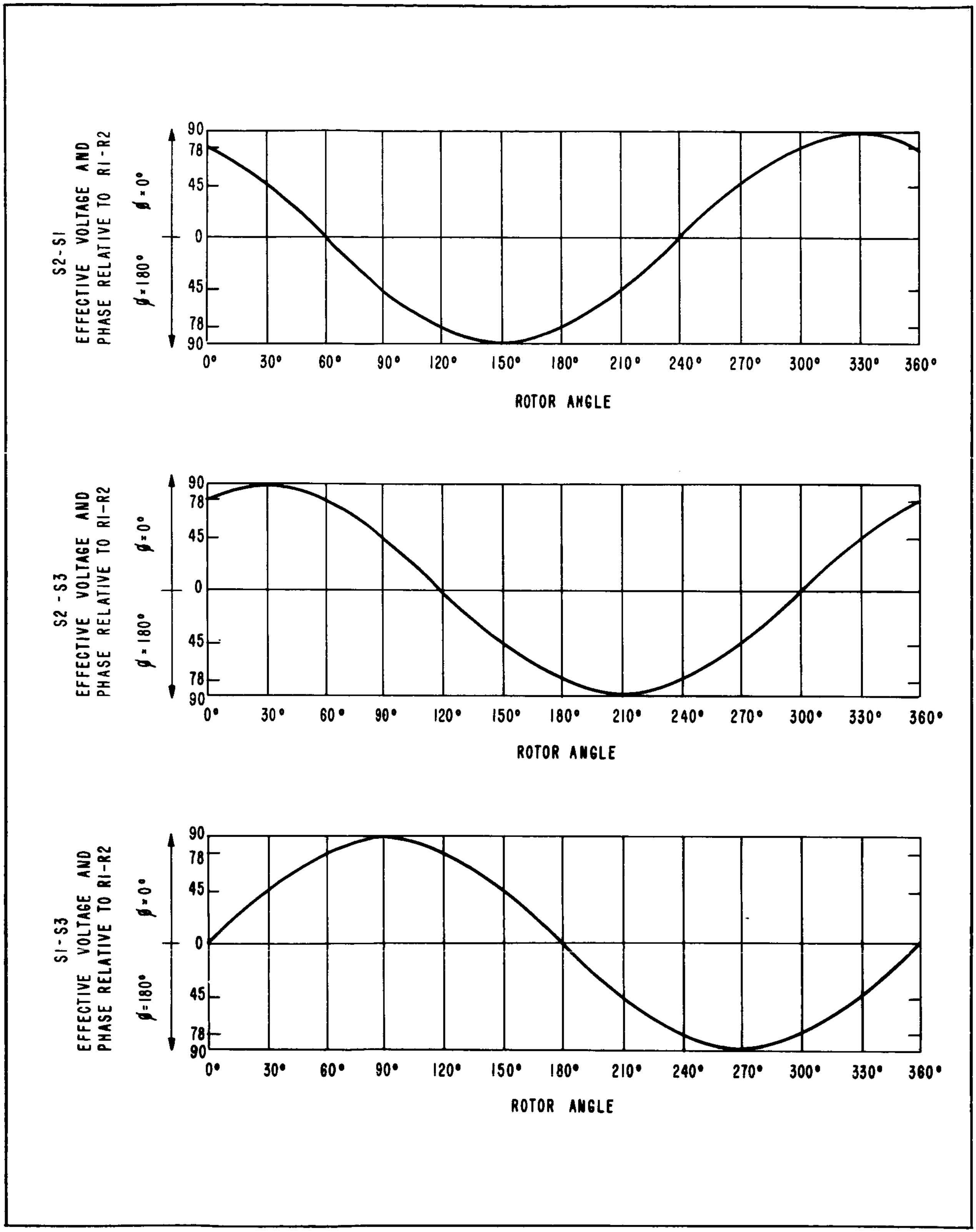


Figure 4-13. Voltages between Synchro Stator Windings

S2 to S2, and S3 to S3. The rotor windings of the transmitter and receiver are connected in parallel and are supplied by 115 VAC reference.

Note

All of the stator windings in a synchro system must be connected to a common reference voltage source. Otherwise, phase differences between voltage sources will cause inaccuracies in the system.

With the reference voltage applied and both of the rotors at zero degrees, as shown in figure 4-14, voltages in the stator windings are 52 VAC for the S2 windings and 26 VAC each for the S1 and S3 windings.

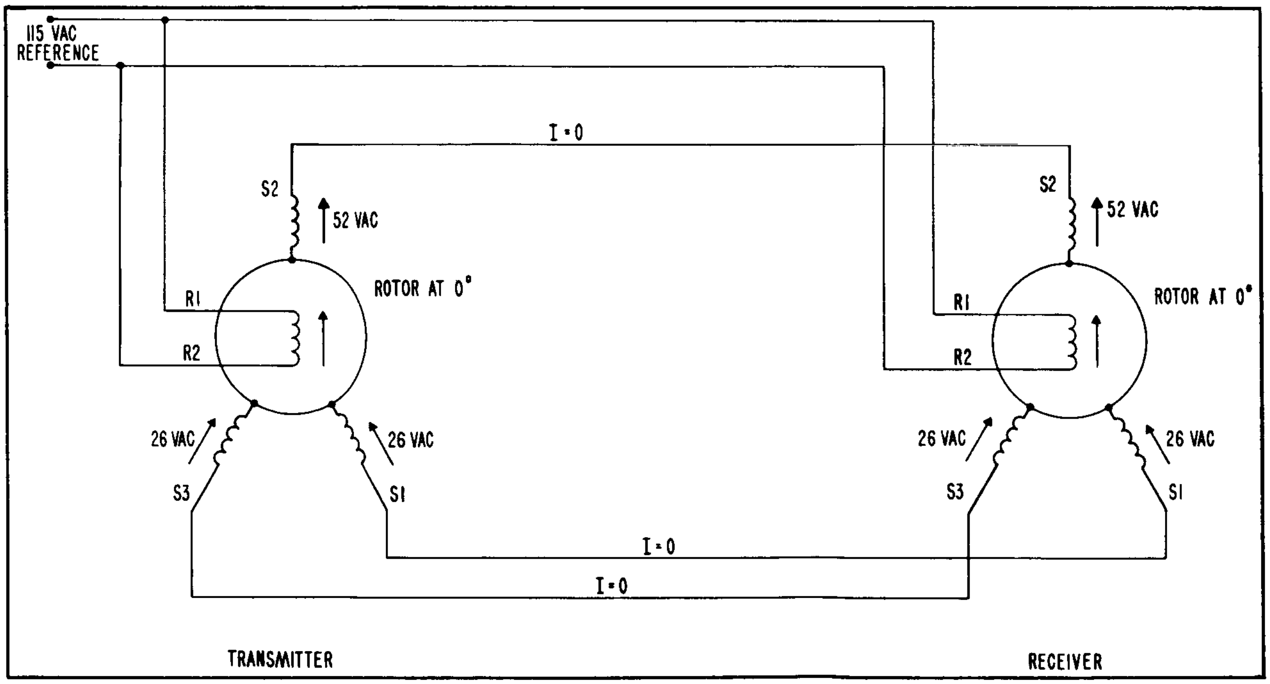


Figure 4-14. Simple Synchro System with Transmitter and Receiver Rotors at the Same Position, Schematic Diagram

The arrows on the illustration adjacent to the windings indicate relative instantaneous current direction (relative phase). As can be seen from figure 4-14, with both the transmitter and receiver rotors at the zero position, the magnitudes of the voltages induced in the stator windings of the transmitter and receiver are the same, and the phases are such that no current flows through the windings. With no current in the windings, no torque is developed and both synchros remain at rest. This condition of dynamic balance (voltages and phases such that no current flows in the stator windings) exists whenever, but only so long as, the rotors of the transmitter and receiver are at the same angular position.

(f). If the synchro receiver is held at one position and the transmitter turned to another position, unbalanced stator voltages are developed and current flows in the windings. An example of this condition is shown in figure 4-15. The rotor of the transmitter is turned

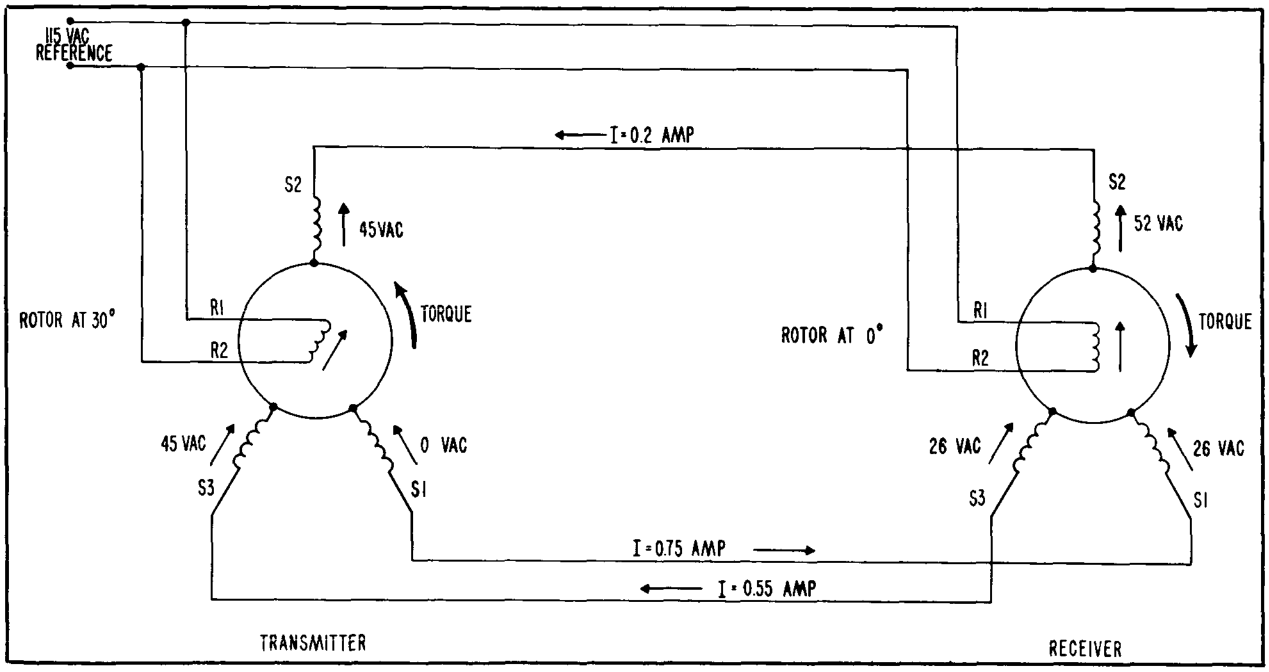


Figure 4-15. Simple Synchro System with Transmitter and Receiver Rotors at Different Positions, Schematic Diagram

inducing stator voltages of the magnitudes and relative phases shown on the illustration. (For the magnitude and relative phase of the induced stator voltages at any position of the rotor, see figure 4-12.) The rotor of the receiver, however, is at a different position, zero degrees, and the voltages induced in its stator windings are different from those in the stator of the transmitter. Currents with the relative phases shown flow in the stator windings. The magnitudes indicated for the currents are typical values. These currents cause torque to be applied to the rotors of the synchros and both of the rotors try to turn. Under the conditions shown on figure 4-15, the transmitter rotor will try to turn in a counterclockwise direction and the receiver rotor in a clockwise direction. The transmitter rotor, when it is mechanically coupled to an antenna or a handwheel, is not free to turn, but the receiver rotor is free to turn. Thus, the receiver rotor turns to the same position as the transmitter rotor and the system comes to dynamic rest. In the same manner, if the transmitter rotor is turned to some new position, the receiver rotor follows. The synchros used in the acquisition system have sufficient sensitivity that as long as reference voltage is applied and the units are operating normally, a receiver will always follow the transmitter to which it is connected within a small fraction of a degree; the receiver is always at virtually the same position as the transmitter, regardless of whether the transmitter is stationary or is being turned. Hence, a pointer or dial attached to the receiver rotor provides an indication of the angular position of the device—in most cases an antenna—to which the transmitter rotor is coupled.

(g). Either a single receiver or several receivers in parallel may be driven by a single transmitter. The acquisition system employs both of these arrangements.

(h). A variety of nomenclature is applied to synchros. The most common of these are listed and explained below:

1. Torque receiver (TR): a synchro receiver.

2. Torque transmitter (TX): a synchro transmitter which can drive a relatively large mechanical load (on the receiver or receivers connected to the transmitter).

3. Control transmitter (CX): a synchro transmitter which can drive only a relatively small mechanical load (on the receiver or receivers connected to the transmitter).

Note

Both torque transmitters and control transmitters are synchro transmitters as described in the previous paragraphs, and except for the amount of load they can drive, they are the same.

4. Synchro generator: a synchro transmitter.

5. Synchro motor: a synchro receiver.

6. Control transformer (CT): this device is described in the following paragraph.

7. Selsyn, Autosyn: trade names for synchros.

(2). CONTROL TRANSFORMERS

(a). The control transformer is a type of synchro unit widely used in automatic control systems. Its function is to supply an a-c voltage whose magnitude and phase polarity depend on the difference between the angular position of its rotor and the rotor of the synchro transmitter which is connected to it. Control transformers are used in various places in the antenna positioning and other systems which are part of or are connected to the acquisition system.

(b). Control transformers are similar to synchro transmitters and receivers, but differ from them in several important respects:

1. The rotor winding of a control transformer is never connected to an a-c supply and therefore induces no voltage in the stator windings. As a result, the stator current is determined only by the impedance of the windings, which is high, and it is not appreciably affected by the rotor's position. (A matched set of delta-connected capacitors is connected across the stator leads near the control transformer. These capacitors correct the lagging power factor of control transformer coils and reduce the current drawn from the synchro transmitter). Also, there is no appreciable current in the rotor, and the rotor does

not tend to turn to any particular position when voltages are applied to the stator. The rotor of a control transformer is always turned by some mechanical device, such as an antenna. (Or more specifically, by gearing between an antenna and the control transformer.)

2. The zero position of a control transformer is that at which the rotor is at right angles to the S2 stator winding. (See figure 4-16.) Note that this zero position differs by 90 degrees from that of a transmitter or receiver (figure 4-14).

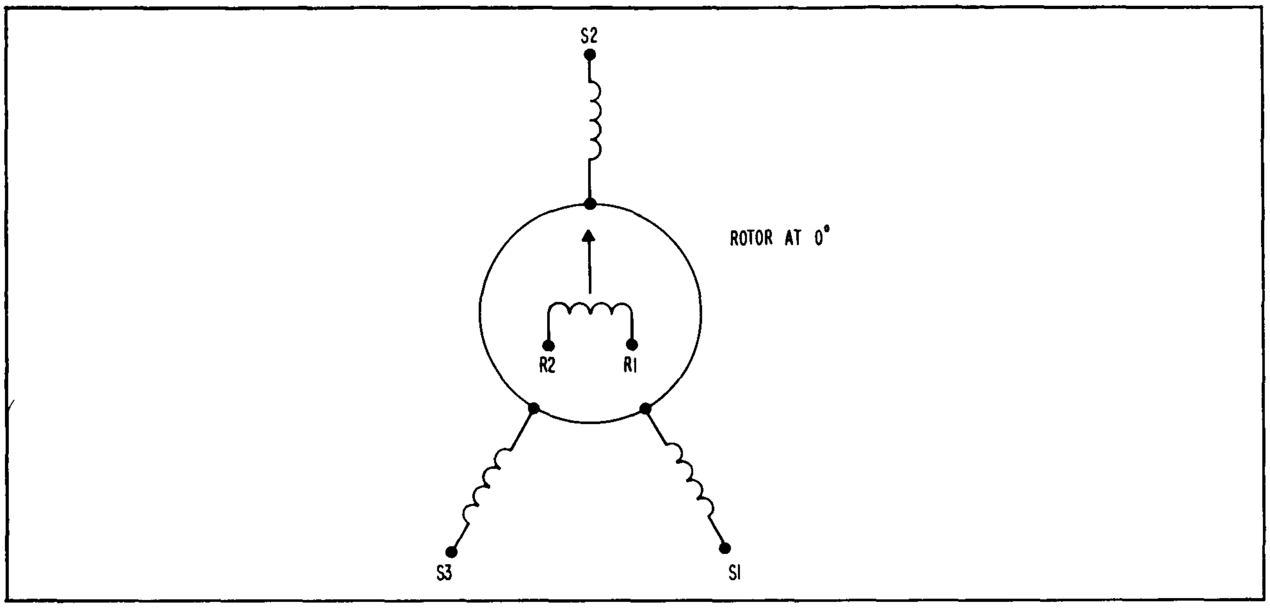


Figure 4-16. Control Transformer, Schematic Diagram

(c). The manner in which a control transformer is connected in a system is shown in figure 4-17. The stator windings of the control transformer are connected to the corresponding stator windings of a synchro transmitter. The rotor of the control transformer is usually connected to a servo amplifier. With a reference voltage (115 VAC) applied to the rotor of the transmitter, voltages are induced in the stator windings of the transmitter. These voltages are representative, by magnitude and phase polarity, of the angular position of the rotor. Since the stators of the control transformer and transmitter are connected, currents flow in the windings, and if the control transformer rotor is at any position except the same as or 180 degrees different from that of the transmitter rotor, voltage is induced in the control transformer rotor.

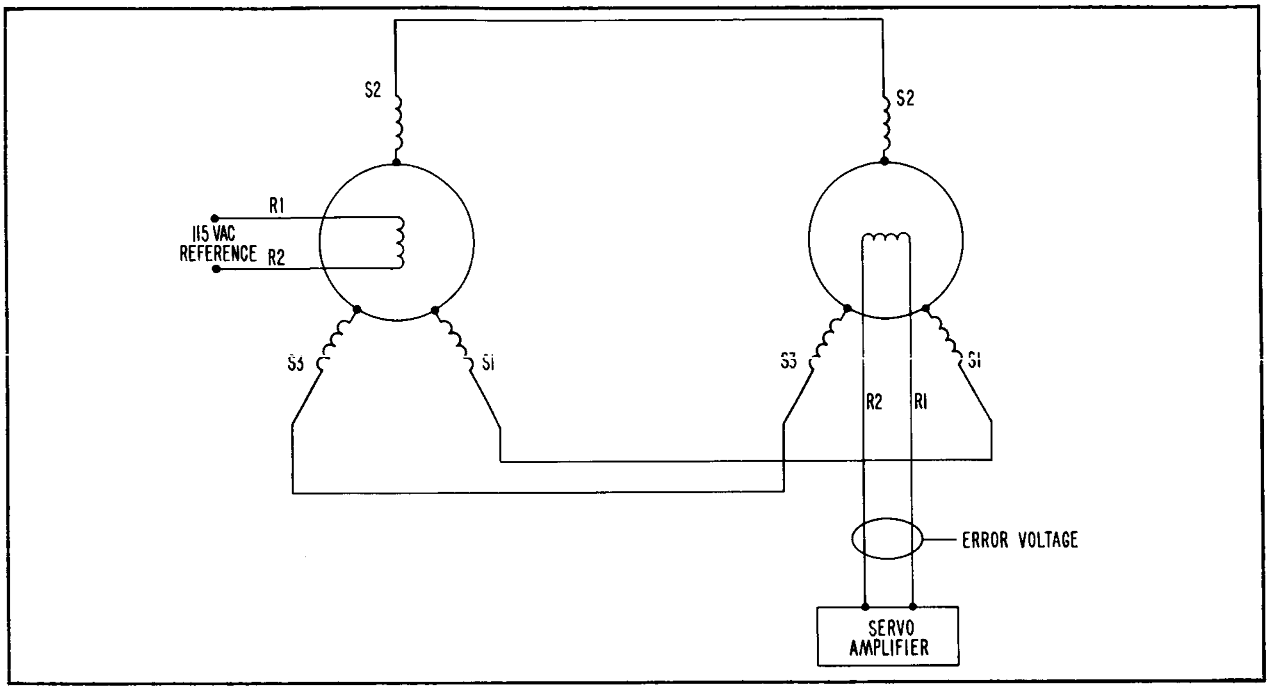


Figure 4-17. Control Transformer and Synchro Transmitter Connections, Schematic Diagram

(d). The voltage induced in the control transformer rotor when it is at a position different from the transmitter rotor depends in magnitude and phase polarity on the angular difference between the two rotors. The voltage variation for 360 degrees of angular difference between the positions of the two rotors is shown on figure 4-18. Note that the rotor voltage has two null points: at positions which are zero and 180 degrees different from the position of the transmitter rotor. When the control transformer rotor is between zero and 180 degrees relative to the transmitter rotor (voltage curve above zero line on figure 4-18), the control transformer rotor voltage is of one phase; between 180 and 360 degrees (voltage curve below the line on figure 4-18), it is of the opposite phase.

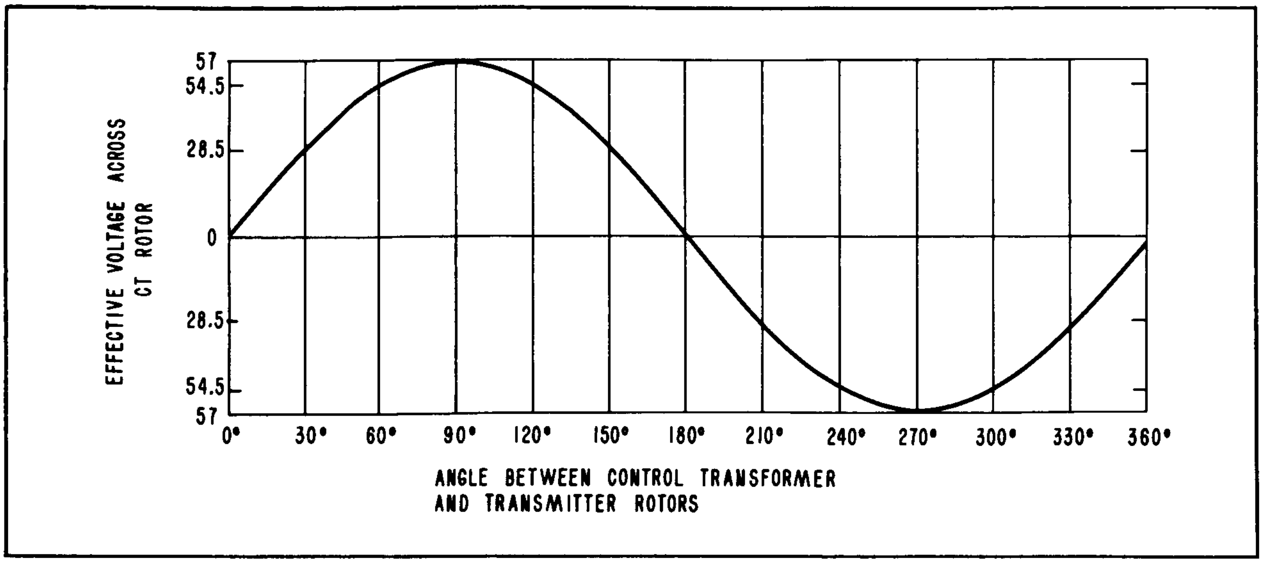


Figure 4-18. Voltage in Rotor Winding of Control Transformer

(e). For a description of how control transformers are used, refer to paragraph 4-2.I.

I. TYPICAL SERVO SYSTEMS UTILIZING SYNCHROS.

In the acquisition system and the equipment associated with it there are a number of servo systems which utilize synchros. A simplified version of a servo system of this type is described in this paragraph in order to provide a basic understanding of how mechanical position data is converted to electrical form, transmitted over a distance, and converted back to mechanical form. Figure 4-19 illustrates such a system.

(1). The principal elements of the system are a mechanical input (the handwheel on figure 4-19), a mechanical/electrical converter (the synchro transmitter), an electrical/mechanical converter (the servo loop consisting of the control transformer, the servo amplifier, and the servo motor), and a mechanical output, or load (the antenna).

(2). The output of the synchro transmitter is a function of the position of its rotor, which is mechanically coupled to the handwheel. The output of the synchro transmitter is connected to the control transformer, whose rotor may or may not be at the same angular position as that of the transmitter. (Refer to paragraph 4-2.H. for a description of the operation of synchro transmitters and control transformers.)

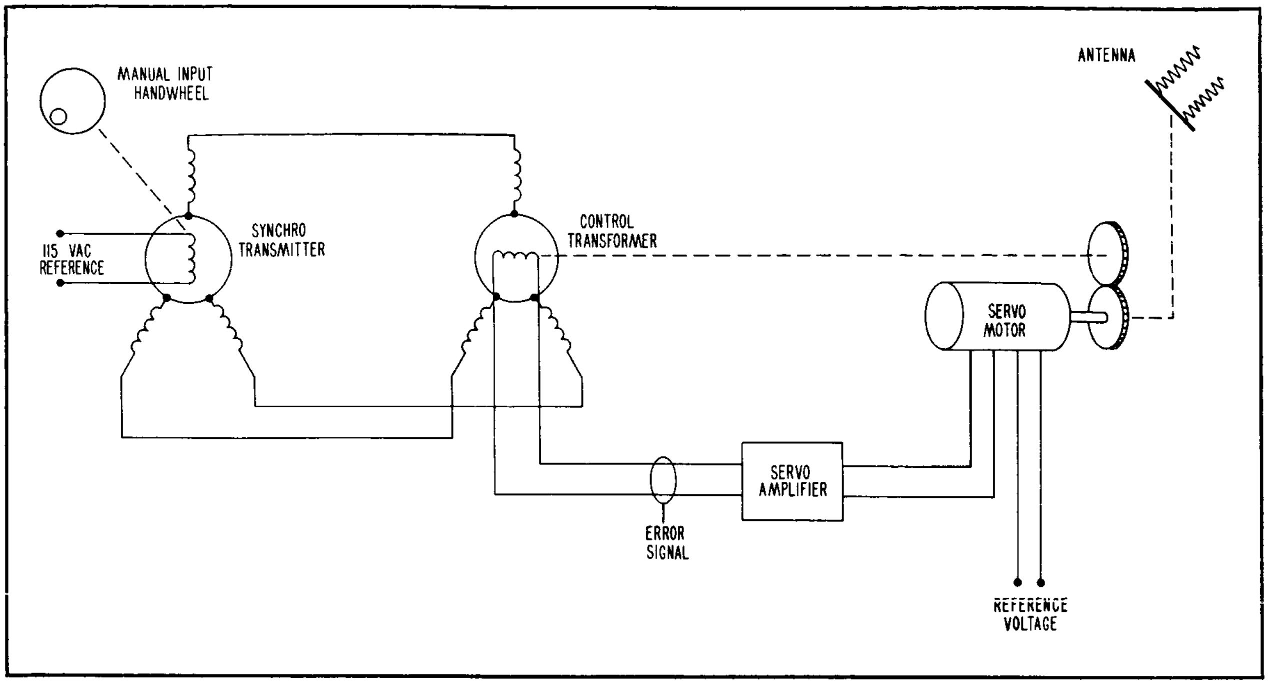


Figure 4-19. Typical Servo System Utilizing Synchros, Simplified Schematic Diagram

When the control transformer rotor is not at the same position as the rotor of the transmitter, a voltage is developed in the control transformer rotor winding. The magnitude and phase polarity of this voltage depend on the angular difference between the positions of the two rotors. This voltage, the error signal of the servo loop, is applied to the servo amplifier, where it is amplified and applied to the variable-phase field winding of a two-phase motor. A reference voltage is applied to the fixed-phase field of the motor. The direction of rotation of the motor depends on the phase of the error signal (relative to the reference voltage), and the speed of rotation of the motor depends on the magnitude of the error signal. When no error signal is applied, the motor does not rotate. The motor armature is coupled through gearing to the rotor of the control transformer and to the mechanical load, in this example an antenna. The gearing and phase of signals in the servo loop are so arranged that whenever there is an error signal developed across the rotor of the control transformer, the motor turns in the direction which results in a reduction of the magnitude of the error. Stated another way, the motor drives the rotor of the control transformer so that it is always at very nearly the same position as the rotor of the synchro transmitter. Since the antenna is also driven by the motor, it too is kept at virtually the same position as the transmitter rotor. Thus, the antenna follows the handwheel which turns the synchro transmitter rotor.

(3). The servo systems actually used in the acquisition system and associated equipment are generally more elaborate than that just described, but the principal elements of the systems are the same. For instance, the voice and command transmitting antenna uses an amplidyne and a d-c servo motor in each channel of its antenna positioning system. The d-c servo motor however, has exactly the same basic function as the two-phase, a-c motor on figure 4-19, and the amplidyne is in its function simply an additional, two-stage servo amplifier.

SECTION V
SYSTEM MAINTENANCE

5-1. GENERAL

This section includes information, instructions and procedures for preventive maintenance, trouble shooting, adjustments and repair, lubrication, special tools, and test equipment. Detailed information is given only for the acquisition data console and its components; for other equipment in the system, system-level and general information is given. For detailed information on the other equipment in the system, refer to the applicable equipment manuals, listed in table 1-II.

WARNING

An antenna drive power cutoff switch and warning light is mounted below the platforms of the voice and command transmitting antenna. When drive power is applied to the pedestal, the warning light is lit. The switch should be turned off (thus removing drive power from the pedestal) before going onto the antenna platform for maintenance or repair.

5-2. PREVENTIVE MAINTENANCE

A. PREVENTIVE MAINTENANCE SCHEDULE

Table 5-I outlines the preventive maintenance procedures which are to be performed on all of the equipment in the acquisition system except the TLM-18. (For TLM-18 preventive maintenance procedures, see the TLM-18 equipment manual.) Detailed procedures are discussed in paragraph 5-2. B. and the equipment manuals.

B. PREVENTIVE MAINTENANCE PROCEDURES

(1). PAINTED SURFACES

Painted surfaces which have corroded should be sanded to remove all of the corroded material and then painted with a color which matches the original. If matching paint is not available, apply any available paint. When matching paint is obtained, paint non-matching areas for the sake of appearance.

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE

Equipment	Maintenance To Be Performed	Refer To
	WEEKLY	
All	Check for corrosion of painted and plated surfaces. Clean and resurface all corroded areas.	Paragraphs 5-2. B. (1). and (2).
All	Check mechanical condition of switches to see that they are not loose or sluggish in their action. Replace any that appear likely to become defective.	—
All except Acquisition Data Console	Check the lamps or bulbs in all indicators. Replace any that are burned out.	Equipment manuals
Acquisition Data Console	Check and replace any burned out lamps in the 28 VDC power supply indicators.	Paragraph 3-2. B.
Acquisition Data Console	Check and replace any burned out lamps in the source switch indicators.	Paragraph 3-2. D.
Acquisition Data Console	Check and replace any burned out lamps in all of the indicators not covered by the previous two steps.	Paragraph 3-5. A.
	MONTHLY	
All	Perform general cleaning as necessary. Wipe off, vacuum off, or blow out dust, dirt, and sand. Clean dial plates (glass) on synchro displays.	—
All	Check and correct as necessary the general condition of equipment. Check cables and wiring for worn or frayed insulation, check connectors to see that they are free from corrosion and are tight, and check terminal board connections for tightness.	—
Synchro Remoting System Units	Clean intake and exhaust air filters with soap and water and apply new, thin film of oil.	—

(2). PLATED SURFACES

Corrosion of plated surfaces (cadmium, nickel or other) should be removed with sandpaper or emery cloth and sprayed or brushed with clear lacquer. If clear lacquer is not available, the corroded areas should be painted to prevent further corrosion until lacquer can be obtained.

5-3. TROUBLE SHOOTING

This paragraph provides information to aid in the isolation and correction of troubles in the acquisition system. It is concerned primarily with those malfunctions which affect the transmission of acquisition information; for information on a malfunction which affects only an individual piece of data-source or data-using equipment, refer to the applicable equipment manual. Since the d-c indication and synchro portions of the acquisition system are essentially independent of one another, they are treated separately in the following discussions.

A. D-C INDICATIONS

The d-c indication circuits in the acquisition system are simple and straightforward and should pose little difficulty in trouble shooting. When a d-c indicator fails to operate properly, refer to the diagrams in Section VII (both the individual equipment schematics and the interconnecting circuit schematics) and to the applicable portions of paragraph 5-4 for information on isolating and ascertaining the source of trouble. The source of the trouble will, in most instances, be obvious on examination of the circuits involved. For information on inter-equipment wiring, refer to Section II, and for information on the internal wiring of equipment other than the acquisition data console, refer to the applicable equipment manual.

B. SYNCHROS

This paragraph comprises three sections: criteria for distinguishing actual troubles (requiring repair or replacement to correct the malfunction) from those malfunctions which can be corrected by adjustment; system trouble analysis; and circuit trouble analysis. The material on system trouble analysis provides information to aid in isolating the trouble to a particular circuit, or portion of the system. The material on circuit trouble analysis will aid in further isolating and determining the exact nature of the trouble. Both the system and circuit trouble analyses are concerned with actual troubles, not misadjustments. For synchro adjustment procedures refer to paragraph 5-4. B.

(1). CRITERIA FOR DISTINGUISHING TROUBLE FROM MISADJUSTMENT

A synchro device is not operating properly when it does not accurately, rapidly, and smoothly transmit or follow the angular information which is fed into it. If a synchro has an error in the information it puts out, but the error is small and essentially constant and the output of the synchro follows the input smoothly and rapidly, the cause of the improper operation is most likely misadjustment. (For a transmitter the input is mechanical and the output is electrical. For a receiver the input is electrical and the output mechanical. For a control transformer there are two inputs, one electrical and one mechanical, and one output, electrical.) If the synchro follows the input but with changing error, does not follow the input, spins, oscillates, hunts, follows erratically, has a large error (about 60 degrees or more), hums, overheats, or exhibits a combination of these or similar symptoms, the cause is most likely an actual trouble, either in the synchro being observed, another synchro connected to it, or the circuits between the two. (Improper adjustment of the synchro line amplifier, however, will cause a varying error in the system which is not due to an actual trouble. The peak value of such error is dependent on the amount of amplifier output imbalance.)

(2). SYSTEM TROUBLE ANALYSIS

Trouble shooting of the synchros in the acquisition system requires a thorough knowledge of the basic principles of synchros and the particular way in which they are used in the system. (Refer to Section IV.) With this knowledge it should be evident from the pertinent schematics, especially figure 5-8 and the interconnecting circuit schematics in Section VII, what the possible causes are for any given trouble. However, keep the following points in mind:

(a). A defective synchro can degrade the performance or cause abnormal operation of any or all synchros which are connected directly to it; for instance, where two receivers (or a receiver and a control transformer) are wired in parallel, a defect in one of them may cause abnormal operation of both. In cases where several synchros have abnormal operation, it will help in isolating the trouble to disconnect, one at a time, each of those involved to see which is affecting the operation of the others.

(b). Outside of the synchro remoting system, the reference voltage (rotor) circuits are virtually the only circuits the azimuth and elevation channels have in common. If abnormal operation shows up in both azimuth and elevation channels in a portion of the acquisition system, look for trouble in the reference voltage circuits.

(c). Troubles that show up just after installation or replacement of synchro units are most likely due to incorrect wiring connections, not to defective units.

(d). When a trouble occurs, be sure to check all connecting circuits very thoroughly. Synchros themselves, although delicate instruments, are generally very reliable and trouble-free devices.

(3). CIRCUIT TROUBLE ANALYSIS

Once it has been determined that the source of trouble is in a particular circuit or portion of the system, circuit trouble analysis may be performed by one or a combination of the following means:

(a). Use of the synchro trouble shooting chart, figure 5-1: This chart graphically shows the symptoms and causes of most of the common synchro troubles, including incorrect wiring connections.

(b). Checks of connecting circuits: All of the circuits between synchros in a malfunctioning portion of the system should be checked in accordance with the applicable portions of paragraph 5-4 and the applicable equipment manuals. See also the interconnecting circuit diagrams in Section VII.

(c). Synchro voltage checks: In some instances it may not be possible to turn the suspected synchros as is necessary when using figure 5-1. In such instances the synchro voltages can be checked: Transmitter and receiver rotor voltage should always be 115 VAC. Transmitter, receiver and control transformer stator voltages should be as shown by the curves of figure 4-13. Control transformer rotor voltage should be as shown in figure 4-18.

5-4. ADJUSTMENTS AND REPAIR

A. GENERAL

This paragraph describes, on an individual basis, adjustment and repair procedures for synchros, the 28 VDC power supply, relays, and switch and indicator assemblies. Also described are adjustment procedures for the synchro line amplifier. For detailed information on other components of the acquisition system, see the applicable equipment manual. The repair procedures given here are based on the assumption that a particular component, such as a relay, switch, or synchro, is known or suspected to be malfunctioning. The procedures are for the isolation and correction of the specific cause of trouble. For general, or system, trouble shooting procedures, see paragraph 5-3.

B. SYNCHRO ALIGNMENT

(1). GENERAL

(a). This paragraph describes procedures for alignment and zeroing of synchro transmitters, receivers, and control transformers, individually and while operating in a system. Also described are procedures for 180-degree reversal of synchro receivers.

(b). In a general sense, "zeroing" a synchro means adjusting it mechanically so that it will work properly in a system with one or more other synchros. Specifically, "zeroing" means aligning the mechanical and electrical zero positions of a synchro. Mechanical zero of a synchro is defined as the rotor position at which the mechanical device coupled to the synchro is at its zero position. For instance, a synchro transmitter coupled to the elevation drive of an antenna is at mechanical zero when the antenna is at zero degrees elevation; and a synchro receiver driving an azimuth indicator is at mechanical zero when the indicator pointer or dial reading is zero degrees azimuth. Electrical zero of a synchro is defined as the position of the rotor when rated voltage is applied to the rotor, when there is no voltage difference between S1 and S3, and when rated voltage is applied between S2 and S1-S3 in such a way that the voltage at S2 (measured with respect to S1-S3) is in phase with the voltage at R1 (measured with respect to R2). The applied voltages and the rotor position at electrical zero are shown in figure 5-2. The voltages shown are the rated values for the synchros used in the acquisition system.

Note

The synchros in the HF antenna positioning systems, which are not functionally a part of the acquisition system, have a different rated rotor voltage, 32 VAC.

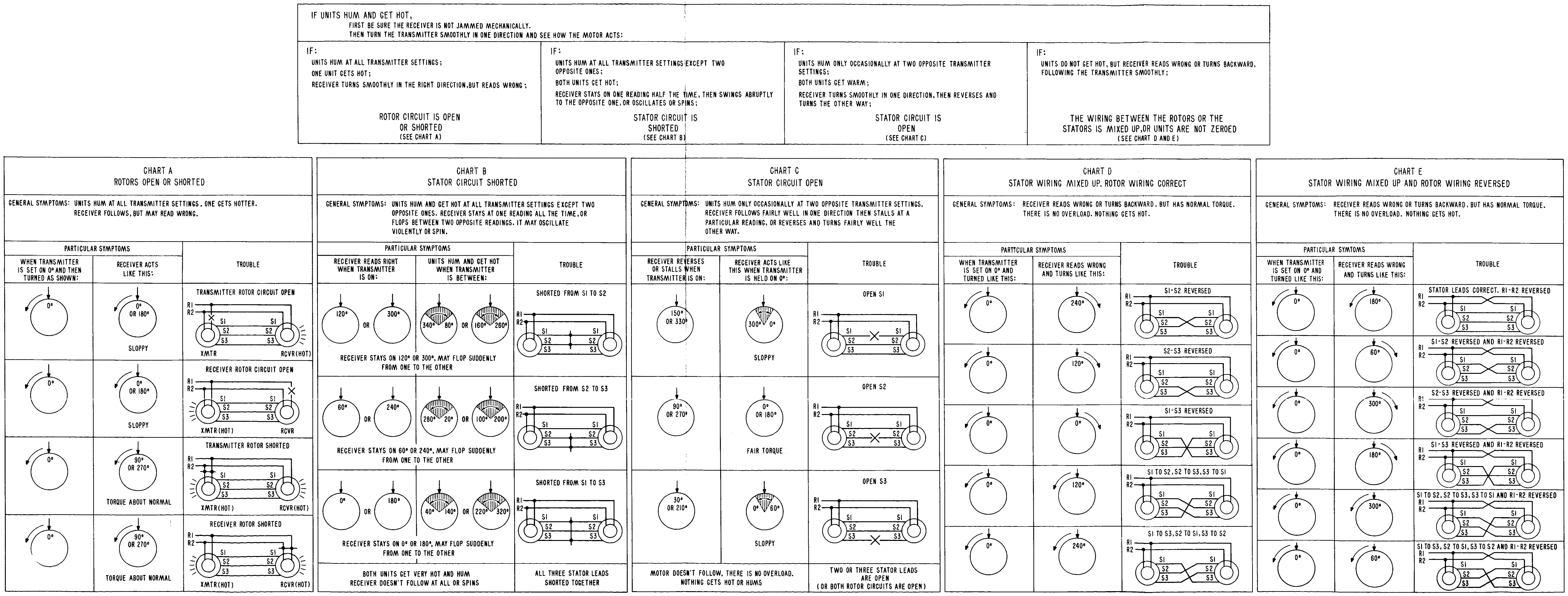


Figure 5-1. Synchro Troubles and Symptoms

For purposes of definition, the arrangement shown in figure 5-2 applies both to synchro transmitters and receivers, and it is actually used for zeroing receivers. However, since synchro transmitters in operating position are not free to turn, a more convenient zeroing procedure is described below. The electrical zero position of a control transformer is as described in paragraph 4-2.H.(2). and shown in figure 4-16.

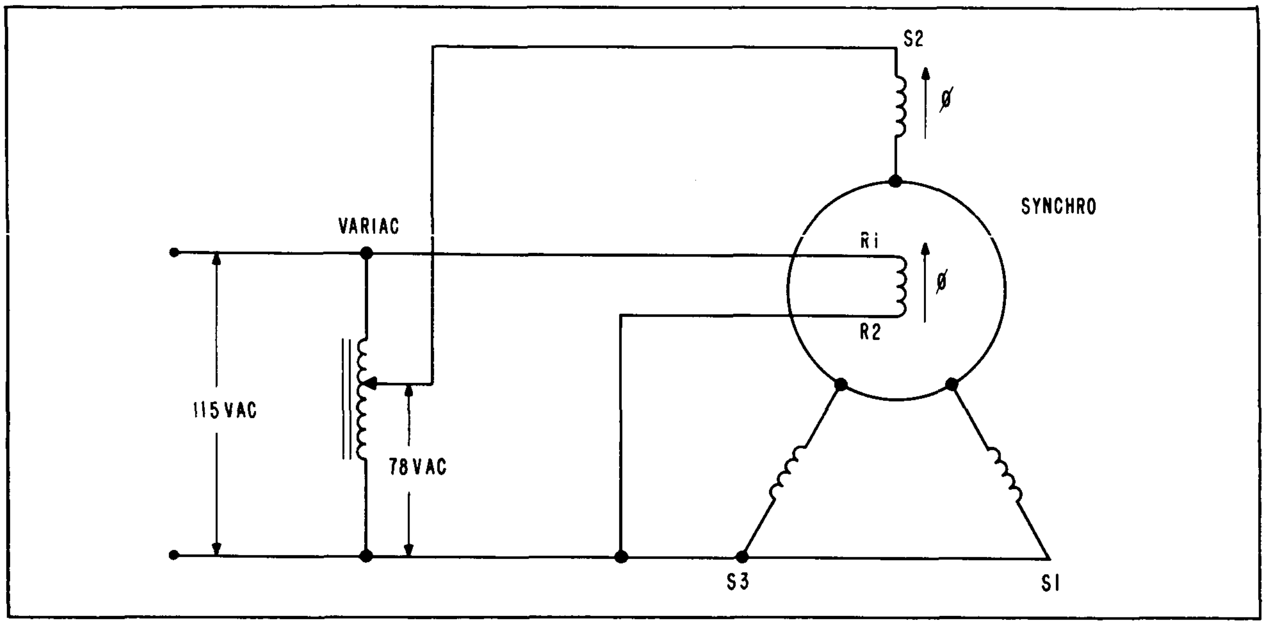


Figure 5-2. Conditions at Electrical Zero of a Synchro

(c). Certain of the synchro receivers used in the acquisition system require special procedures for zeroing. The requirement for special procedures derives from the facts that the R2 and S2 windings are internally connected in all synchros on the acquisition data console and the TLM-18 acquisition bus display panel, that the S2 winding of all synchros connected to a synchro line amplifier is grounded within the amplifier, and that the synchro line amplifier reverses the phase of all synchro stator voltages which pass through it. Hence, with normal connections, synchro receivers connected to the line amplifier would give readings 180 degrees different from what they should; and the usual procedure for correcting a reverse synchro reading (interchanging the R1 and R2 connections) cannot be followed in all cases as it would result in a direct short circuit of the 115 VAC synchro reference voltage. The procedures given below take these conditions into account and except where noted are applicable to all synchros connected to the acquisition system.

(d). The procedures that follow comprise four sections; one for individual zeroing of transmitters, one for individual zeroing of receivers, one for individual zeroing of control transformers, and one for in-system alignment of transmitters and receivers. The first three sections apply, with some exceptions as noted, to any individual synchro transmitter, receiver or control transformer, in the acquisition system. For the synchros in the HF antenna positioning system, the in-system alignment procedure is the most suitable. Refer to paragraph 5-4.B.(5).

(2). SYNCHRO TRANSMITTERS

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous, i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. Normally, it is not necessary to follow the complete procedure. Once the transmitter has been installed and is operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). TRANSMITTER ZEROING PROCEDURE-COMPLETE

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

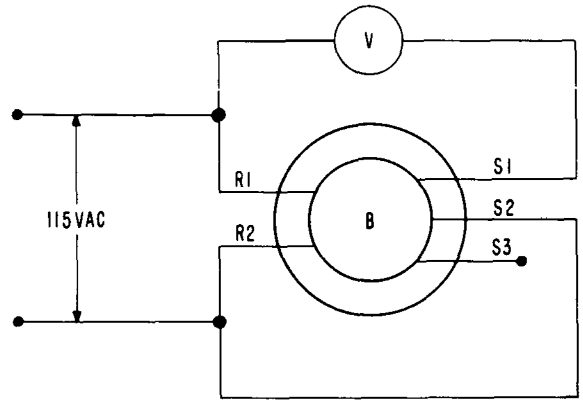
2. Turn off reference voltage to the synchro (115 VAC).

3. Disconnect the stator leads (S1, S2, S3) from the synchro.

4. Connect a jumper between synchro terminals R2 and S2 and connect a voltmeter (Hewlett-Packard 400D, 300 volt scale) between terminals R1 and S1. (See figure 5-3).

CAUTION

Before connecting the jumper between R2 and S2, make sure that the synchro has no internal jumpers which, when the external jumper is connected, would result in a short circuit of the 115 VAC power.



B: SYNCHRO TRANSMITTER
V: HEWLETT-PACKARD 400D AC VTVM

MAKE CONNECTIONS AND APPLY POWER AS SHOWN

APPROXIMATE METER READINGS:
NEAR ELECTRICAL ZERO POSITION - 193 VAC
NEAR ELECTRICAL 180-DEGREE POSITION - 37 VAC

Figure 5-3. Method of Locating Approximate Position of Synchro Transmitter Electrical Zero

5. Apply 115 VAC to the rotor winding (R1 and R2) of the synchro:

a. If the meter reading is approximately 193 volts, the synchro is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 37 volts, the synchro is near electrical 180 degrees. Turn off the 115 VAC reference, loosen the screws which hold the case, and turn the case of the synchro halfway around, so that the meter reading is approximately 193 volts. Then proceed with the simplified zeroing procedure below.

c. If the meter reading is something roughly midway between 37 and 193 volts, the synchro is not near either zero or 180 degrees. Proceed with the simplified zeroing procedure to set the synchro near zero or 180 degrees. Then repeat the complete zeroing procedure.

(b). TRANSMITTER ZEROING PROCEDURE - SIMPLIFIED

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

Note

See paragraph 5-4.B.(2) for restrictions on the use of this procedure.

2. Turn off reference voltage (115 VAC) to the synchro.

3. Disconnect the stator leads (S1, S2, S3) from the synchro.

4. Connect a voltmeter (Hewlett-Packard 400D) between synchro terminals S1 and S3. (See figure 5-4). To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the zeroing procedure, set the meter to successively lower scales.

5. Loosen the screws which hold the case of the synchro so that the case is free to turn.

6. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.

7. Turn the case of the synchro in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the synchro back and forth to

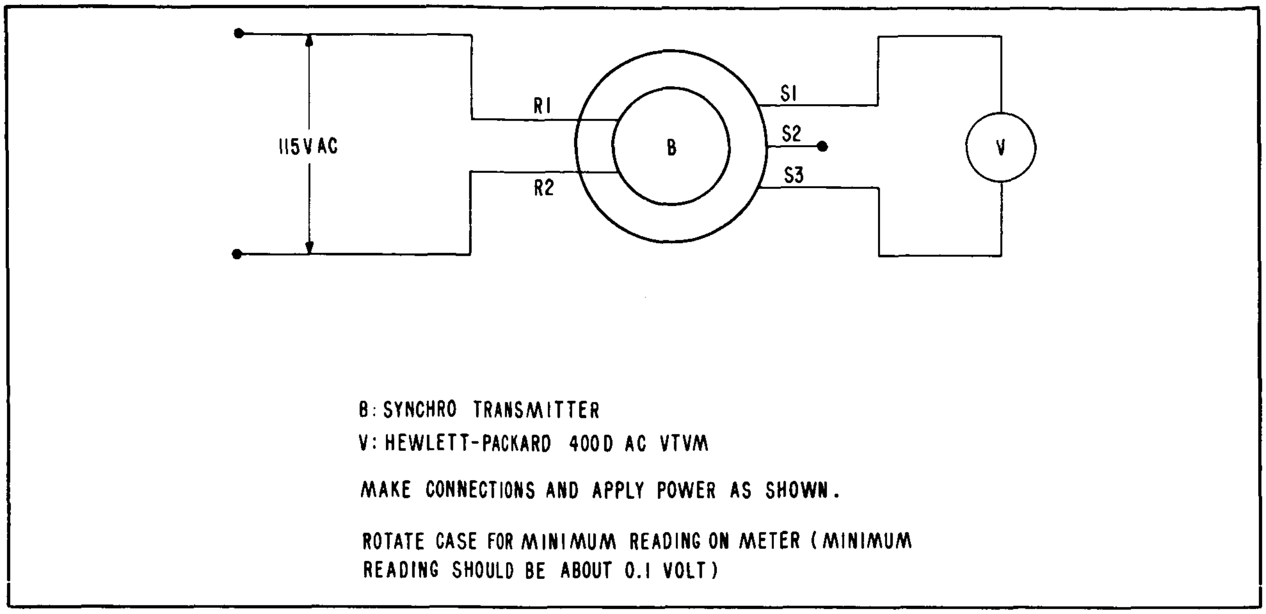


Figure 5-4. Method of Zeroing Synchro Transmitter

locate the position of null voltage on the meter. Null voltage should be about 0.1 volt. This position is the electrical zero of the synchro.

8. With the synchro set at electrical zero, tighten the screws which hold the case in place.

9. Turn off the reference voltage (115 VAC) and reconnect the stator leads (S1, S2, S3).

(3). <u>SYNCHRO RECEIVERS</u>

This paragraph describes procedures for zeroing and for reversing synchro receivers. Two procedures for reversing receivers are described; one of these can be used for any synchro receiver, and the other, which is simpler, is limited in application to those receivers which have no internal or external jumpers between a rotor lead and a stator lead. Synchros with jumpers are hereafter called the four-wire type, and those with no jumpers are called the five-wire type. (All of the synchro receivers on the acquisition data console and those in the TLM-18 acquisition bus display panel are the four-wire type; terminals R2 and S2 are internally jumpered.)

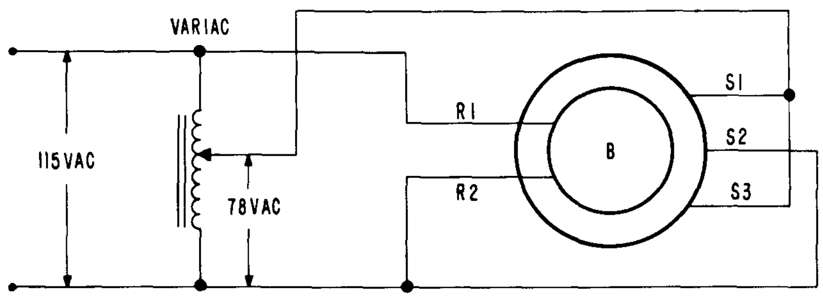
(a). RECEIVER ZEROING PROCEDURE

This procedure is applicable to those synchro receivers which are not supplied from the synchro line amplifier. (The synchro line amplifier reverses the phase of the stator voltages; hence, synchro receivers connected to the output of an amplifier require reversing, not zeroing.)

1. Turn off reference voltage (115 VAC) to the synchro.

2. Disconnect the stator leads (S1, S2, S3) from the synchro.

3. Connect a variac (General Radio Type W10MT) as shown in figure 5-5.



B: SYNCHRO RECEIVER.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN. SYNCHRO WILL TURN TO ELECTRICAL 180°.

TO ZERO: ROTATE CASE OR POINTER FOR SYNCHRO POINTER OR DIAL READING OF 180°.

TO REVERSE: ROTATE CASE OR POINTER FOR SYNCHRO POINTER OR DIAL READING OF 0°.

Figure 5-5. Method of Zeroing or Reversing Synchro Receiver

4. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

5. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn

the case so that the synchro pointer or dial is at 180 degrees.

6. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now zeroed.

Note

The synchro receivers on the acquisition data console and the TLM-18 acquisition bus display panel are so constructed that they cannot be zeroed by turning the case; the pointer must be turned on the rotor shaft. Partially disassemble the synchro and remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4.C.

(b). RECEIVER REVERSING PROCEDURES

The procedures which follow are applicable to synchro receivers which are connected to the output of the synchro line amplifier. Two procedures are described; the first is a very simple method of reversing (changing by 180 degrees) the reading of a receiver, but it cannot be used on synchros with four-wire connections (jumpers between rotor and stator leads) and it does not provide a check of the accuracy of the synchro's indication. The second procedure can be used with either four- or five-wire connection synchro receivers and it provides check and adjustment of the receivers indication inasmuch as it is actually a procedure for "zeroing" at 180 degrees.

1. R1-R2 INTERCHANGE

CAUTION

Do not apply this procedure to any of the synchros on the acquisition data console or TLM-18 acquisition bus display panel or any others which have jumpers, internal or external, between a rotor winding and a stator winding. To do so may result in a direct short circuit of the 115 VAC reference voltage.

a. Turn off the 115 VAC reference voltage.

b. Disconnect the external leads from the synchro R1 and R2 terminals.

c. Connect to R1 the external lead which was formerly on R2.

d. Connect to R2 the external lead which was formerly on R1. The synchro reading is now reversed (different by 180 degrees) from what it was before R1 and R2 were interchanged.

2. "ZEROING" AT 180 DEGREES

a. Turn off reference voltage (115 VAC) to the synchro.

b. Disconnect the stator leads (S1, S2, S3) from the synchro.

c. Connect a variac (General Radio Type W10MT) as shown in figure 5-5.

d. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

e. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at zero degrees.

f. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now reversed.

Note

For the synchros on the acquisition data console, and the TLM-18 acquisition bus display panel, see the note under paragraph 5-4.B.(3).(a). regarding zeroing by turning the pointer on the rotor shaft. For reversing, or "zeroing" at 180 degrees, follow the procedure in the referenced note, except turn the pointer to zero degrees.

(4). <u>CONTROL TRANSFORMERS</u>

Two procedures, one complete and one simplified, for zeroing control transformers are given below. As was discussed for the case of synchro transmitters in paragraph 5-4.B.(2)., the simplified procedure should be used only when the approximate electrical zero position of the control transformer is known. Normally, the approximate electrical zero position is known, and the simplified procedure can in most cases be used.

(a). <u>CONTROL TRANSFORMER ZEROING PROCEDURE-COMPLETE</u>

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

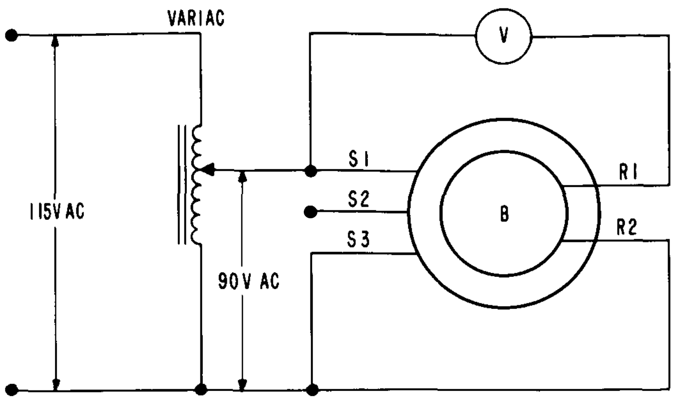
2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals R2 and S3 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-6.)

4. Connect a variac (General Radio Type W10MT) between terminals S1 and S3 as shown on figure 5-6 and apply 90 VAC to these terminals.

<u>a</u>. If the meter reading is approximately 30 volts, the control transformer is near electrical zero. Proceed with the simplified zeroing procedure below.

<u>b</u>. If the meter reading is approximately 120 volts, the control transformer is near electrical 180 degrees. Turn off the power, loosen the screws which hold the case, and turn the case of the control transformer halfway around.



B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER.
(MINIMUM READING SHOULD BE ABOUT 30 VOLTS).

Figure 5-6. Method of Locating Approximate Position of Control Transformer Electrical Zero

Turn the power back on; the meter reading now should be approximately 30 volts. Proceed with the simplified zeroing procedure.

(b). CONTROL TRANSFORMER ZEROING PROCEDURE-SIMPLIFIED

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

Note

See paragraph 5-4.B.(4). for restrictions on the use of this procedure.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals S1 and S3 and connect a voltmeter (Hewlett-Packard 400D) between terminals R1 and R2. (See figure 5-7.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained

during the following steps of the procedure, set the meter to successively lower scales.

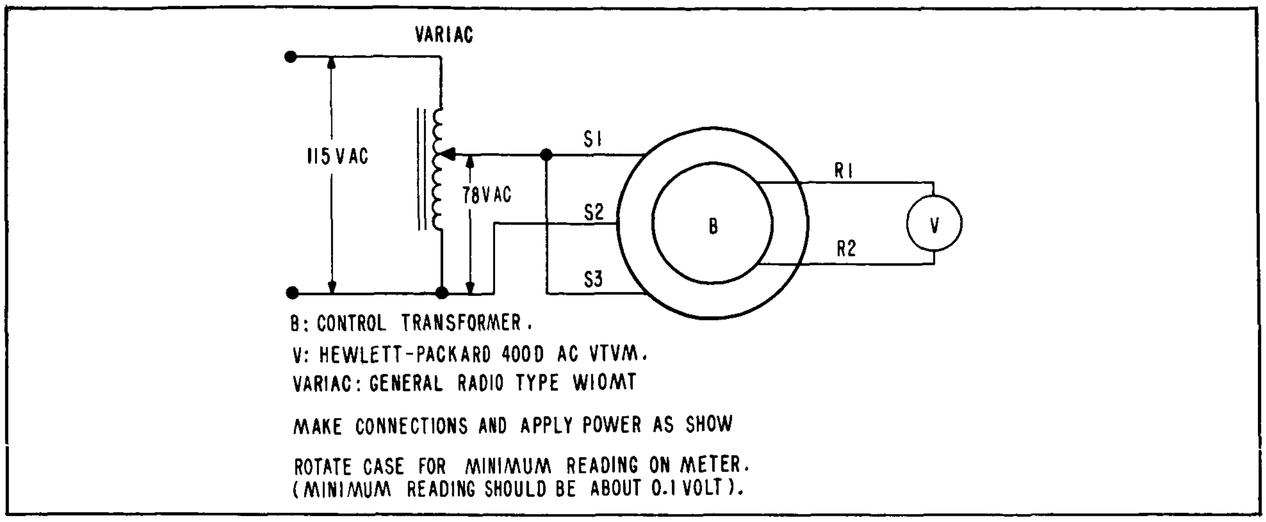


Figure 5-7. Method of Zeroing Control Transformer

4. Loosen the screws which hold the case of the control transformer so that the case is free to turn.

5. Connect a variac between terminals S1 and S2 as shown in figure 5-7 and apply 78 VAC to these terminals.

6. Turn the case of the control transformer in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the control transformer back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the control transformer.

7. With the control transformer set at electrical zero, tighten the screws which hold the case in place.

8. Turn off power and reconnect the control transformer for normal operation in its circuit.

(5). SYSTEM ALIGNMENT

In a system consisting of a synchro transmitter and a synchro receiver or control transformer, there are three places where misalignment errors commonly arise. These three are the transmitter, the receiver, and the circuits which connect the transmitter to the receiver. When the connecting circuits consist simply of cabling and/or fixed transformers, no adjustments can be made to them; errors can be corrected only at the transmitter or receiver. When the connecting circuits include a synchro line amplifier, error-correcting adjustments can be made at the transmitter, the receiver, and at the amplifier. In a simple system consisting of a single transmitter, synchro line amplifier, and receiver or control transformer (a control transformer for the purposes of this discussion being equivalent to a synchro receiver), a misalignment error can be corrected by adjusting any one of the three elements (transmitter, amplifier, or receiver). In such a simple system it is immaterial where the source of error actually is; a misadjustment of the transmitter can be compensated for by adjusting the receiver to introduce an equal and opposite error. The only criterion for proper operation is that when the device which drives the synchro transmitter is pointing at a given angle, the synchro receiver indicates that angle. However, the synchros in the acquisition system are not in a simple arrangement like that just described, and although shortcut methods can and should be used as the technician becomes familiar with the configuration and characteristics of the system, the general procedure given below should be followed in most cases:

Note

The procedure outlined in step (d) below is suitable for the HF antenna positioning system synchros except those in the HF antenna system use 32 VAC for rotor excitation.

(a). When an error is noted in the synchro system, determine if possible whether the error is due to a "trouble" or a misadjustment. The criteria for making this determination are discussed in paragraph 5-3.

(b). Isolate the source of the error as much as possible. That is, where there is more than one receiver connected to a transmitter, check all of the receivers to see whether the error shows up on all or on only one: switch between two transmitters which can be connected to a single receiver. (See figure 5-8. This illustration is a

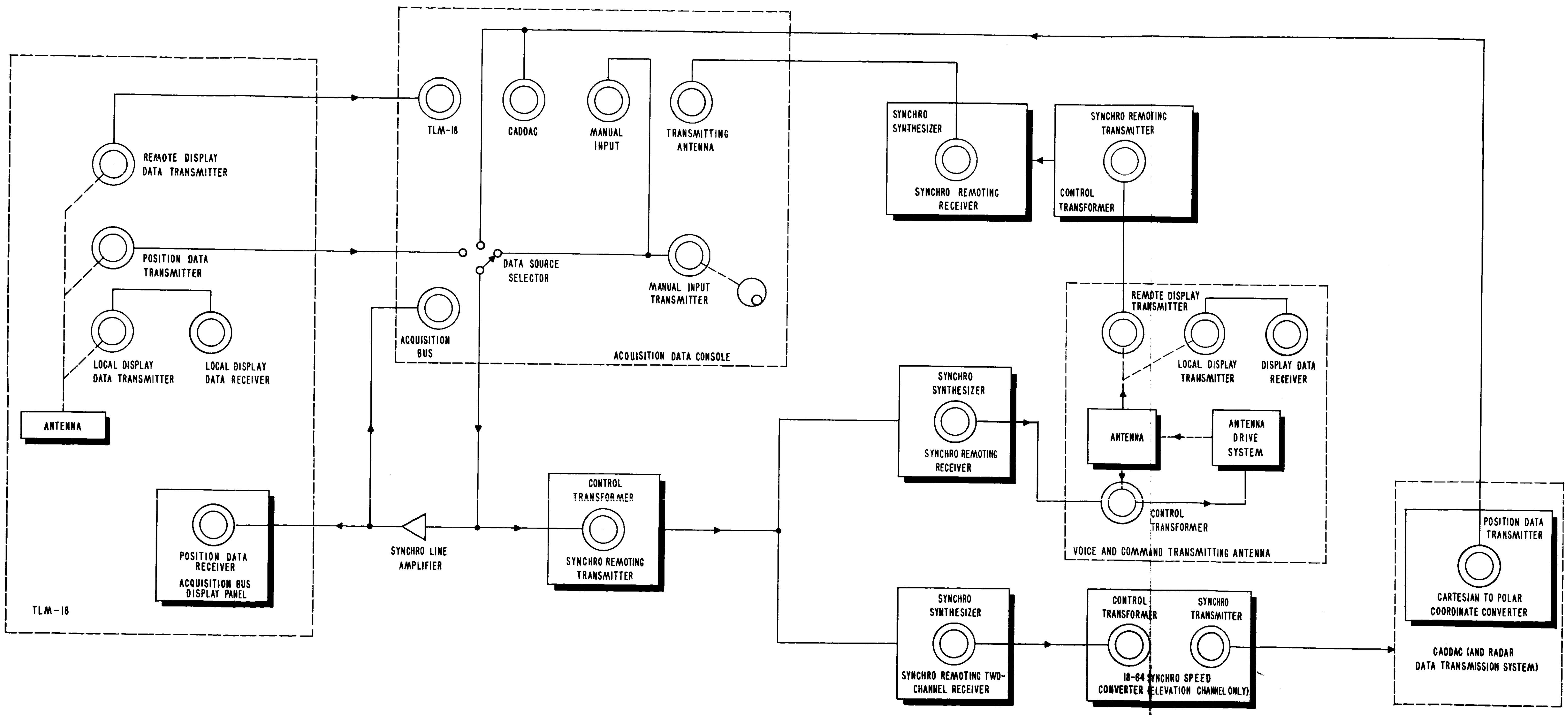


Figure 5-8. Azimuth and Elevation Synchro System, Schematic Diagram

schematic of both the azimuth and elevation synchro systems, which are virtually identical.)

(c). Individually check the adjustment of each of the units (transmitter, receiver, control transformer, and synchro line amplifier) for possible source of the particular error. Careful adjustment of the individual units should correct the majority of system errors. Individual check and adjustment procedures for synchro transmitters and receivers and control transformers are given in paragraphs 5-4.B.(2)., (3)., and (4)., and procedures for the synchro line amplifier are given in paragraph 5-4.G.

(d). When all of the individual units involved have been properly adjusted and the error still persists, its source must be in the connecting cabling. An error arising in the cabling, so long as it is constant at all angular positions of the synchros, can be compensated for by introducing equal and opposite errors into the synchro receivers. Thus, when individual adjustment of the units of the system does not correct the error, system alignment should be made as follows:

1. Do not change the synchro transmitters or synchro line amplifiers; i.e., leave these units as they were set in accordance with the individual adjustment procedure.

2. Set the device mechanically coupled to the transmitter to a known position (azimuth or elevation).

3. For synchro receivers, loosen the screws which hold the case and with the synchros energized (115 VAC applied) turn the case so that the receiver indication is the same as the position of the antenna.

Note

The case of the synchro receivers on the acquisition data console and the TLM-18 acquisition bus display panel cannot be turned; the pointer must be turned on the rotor shaft. Refer to the note in paragraph 5-4.B.(3).(a).

4. Before adjusting a control transformer to compensate for errors introduced by interconnecting cabling, be sure that changing the setting of the control transformer will not introduce an error into the positioning system with which the control transformer is associated.

C. SYNCHRO REPAIR

(1). REPAIR PROCEDURES

(a). It is recommended that major repairs on synchro devices (transmitters, receivers and control transformers) not be attempted in the field. However, minor repairs such as replacing broken pointers on dial plates and repairing broken connections (where wiring is accessible) can be made. For information on replacement of defective parts or gaining access to internal wiring of synchros on the acquisition data console and TLM-18 acquisition bus display panel, refer to the disassembly and assembly procedures below. For information on other synchros in the acquisition system, refer to the applicable equipment manual.

(b). When there is a question as to whether a synchro is defective and requires replacement, the winding resistances should be checked. For the synchros on the acquisition data console and the TLM-18 acquisition bus display panel, the d-c resistance of the stator windings (S1-S2, S2-S3, and S1-S3) should be about 95 ohms at room temperature, and the d-c resistance of the rotor winding (R1-R2) should be about 85 ohms, at room temperature. For synchros in other equipment, comparable d-c resistance measurements should be obtained. (When a resistance measurement is doubtful, compare the resistances of corresponding windings in two identical synchros, or two windings of the same synchro.)

(2). DISASSEMBLY

The disassembly procedure described in this paragraph applies to the synchro receivers on the acquisition data console and the TLM-18 acquisition bus display panel. See figure 5-9.

(a). Dismount the synchro from the panel by removing the four mounting screws and nuts.

(b). Remove the eight screws which hold the bezel onto the front housing. Remove the bezel, dial plate and gasket and set them aside.

(c). Pull or pry the pointer off the end of the rotor shaft. As shipped from the factory the pointer is secured to the shaft with a drop of glue, and considerable force may be necessary to remove it. However, care should be exercised not to break the fragile pointer during removal.

(d). Pull out the retaining ring and remove the dial.

(e). Remove the four screws which hold the front and rear housings together. Remove the front housing and "0" ring. With the front housing removed, only the wires from the connector to the synchro itself hold the synchro in the rear housing. Do not hold the rear housing in such a position that the connecting wires support the weight of the synchro.

(f). Remove the four screws which fasten the connector to the rear housing.

(g). Pull the connector as far away from the rear housing as the wiring permits and unsolder the wires from the connector pins. Drop the synchro itself out of the rear housing. This is as far as field disassembly should proceed.

(3). ASSEMBLY

Assembly of the synchro receivers on the acquisition data console and TLM-18 acquisition bus display panel is the reverse of the disassembly procedure, except that particular attention should be paid to the pointer. Be sure that the pointer is replaced at the proper angle on the rotor shaft [refer to paragraph 5-4.B.(3).], and if necessary crimp the pointer socket slightly to obtain a secure fit on the rotor shaft.

D. 28 VDC POWER SUPPLY

The acquisition data console 28 VDC power supply comprises two principal parts; one is the control circuits, and the other is the dual power supply. The control

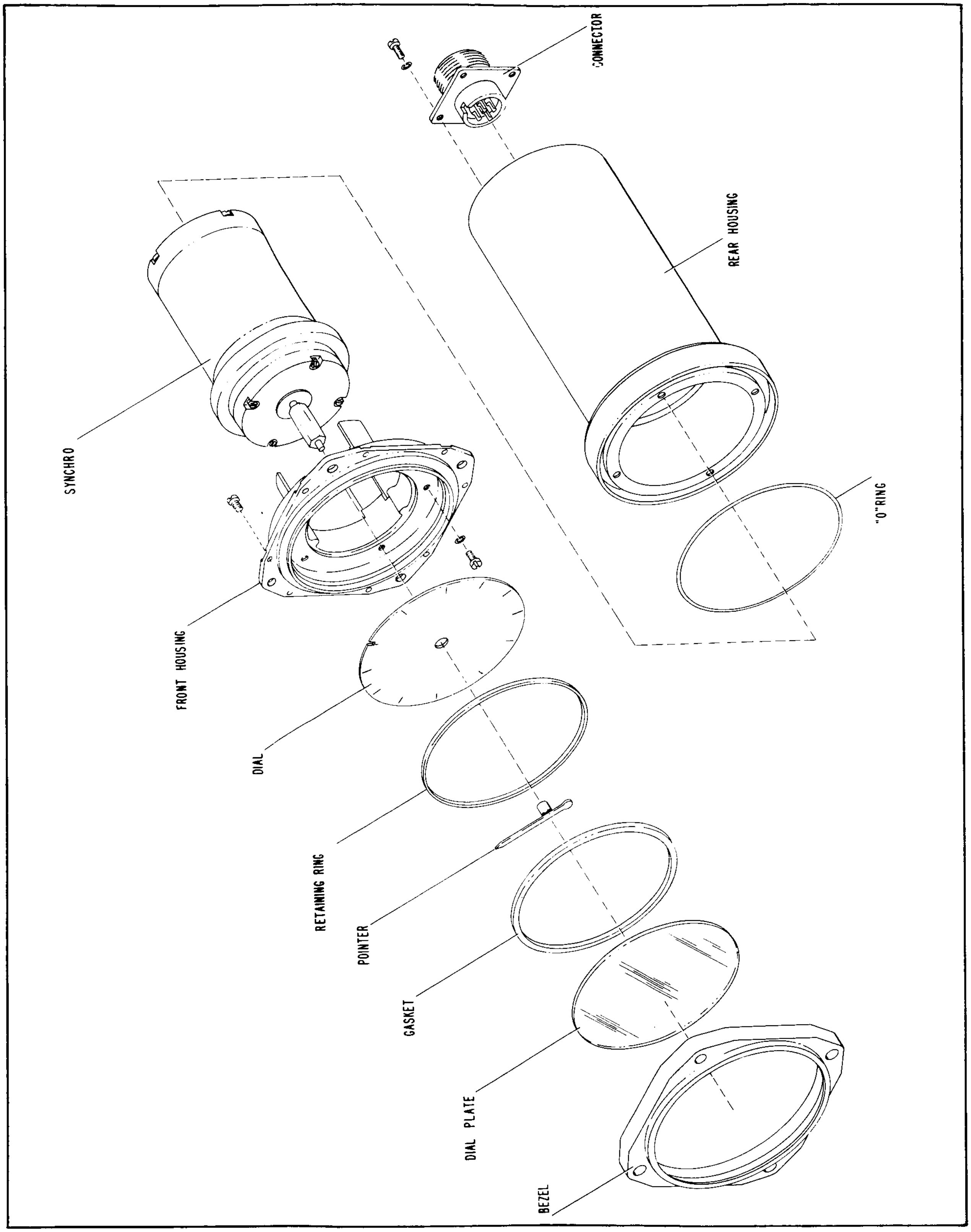


Figure 5-9. Acquisition Data Console Synchro Receiver, Exploded View

circuits consist of relays and diodes on the relay chassis and the switch assemblies (with indicators) on the acquisition data panel. The dual power supply consists of a front panel (with a switch, fuses, and a power-on indicating lamp) and power supplies number 1 and 2, each consisting of a power supply unit and a filter unit. This paragraph describes adjustment and repair procedures for the control circuits and for the dual power supply. Since it is unlikely that a single trouble in the console will affect both power supplies number 1 and number 2 and their associated control circuits, the repair procedures are based on the assumption that only one power supply and/or its associated control circuits is malfunctioning. If neither power supply is operative, check switch S6201 on the dual power supply and check the primary power, 115 VAC, to the console.

(1). CONTROL CIRCUITS

The following procedure is applicable specifically for checking and isolating trouble in the control circuits associated with power supply number 1. With appropriate substitutions in the reference designations of components, terminals, etc., the same procedure is applicable to the control circuits associated with power supply number 2.

(a). With switch S6201 on the dual power supply in the off position, connect a temporary jumper around blocking diode CR6001. The purpose of the jumper is to connect 28 VDC from power supply number 2 to the control circuits of power supply number 1.

(b). Remove plug P6201 from jack J6201 on the dual power supply.

(c). Turn on switch S6201 on the dual power supply and depress switch S6005 on the acquisition data panel. Power supply number 2 is energized and 28 VDC is applied to the control circuits of power supply number 1. If the power supply number 1 control circuits are functioning properly, the green indicator lamps in switch S6004 (on the acquisition data panel) will be lit, and switch S6004 when depressed will stay depressed, connecting 115 VAC to pins A and B of plug P6201 (measure with a voltmeter). Failure to perform as described indicates that the trouble is in the control circuits; proceed as follows to isolate the trouble.

(d). With a voltmeter measure the voltage across zener diode CR6003. It should be 18 ±1 VDC; if it is not, the diode is defective.

(e). Check the coil and contacts of relay K6001. The coil should have a d-c resistance of 1000 ohms. The contacts can conveniently be checked by measuring the voltage drop across each pair that should be closed; there should of course be no voltage across closed contacts.

(f). Check the coil, contacts, and indicator lamps in switch S6004. The coil should have a d-c resistance of 480 ohms. Check the contacts for voltage drop across each pair that should be closed.

(2). DUAL POWER SUPPLY

(a). ADJUSTMENT

The individual power supplies in the dual power supply should be adjusted so that at the maximum normal load imposed by the console and with the prevailing a-c line voltage input to the console, the output of each power supply onto the console 28 VDC bus is as close as possible to 25 VDC. With a given a-c line voltage, a d-c output voltage within the range of 24 to 26 VDC normally should be obtainable. If only the extremes of this range can be obtained, the output voltage should be set at the higher end of the range. Also, the power supplies should be adjusted so that with extremes of line voltage fluctuation and with d-c load variations from minimum to maximum, the d-c voltage output of the dual power supply is in no case greater than 30 VDC or less than 22.5 VDC. Voltages greater than 30 VDC are likely to overheat and thus damage the color filters in the console indicators, and any voltage less than 22.5 VDC may not be sufficient to operate the power supply control circuits. The curves of figures 5-10 and 5-11 are provided for reference in case it is necessary to adjust the power supplies with an a-c line voltage other than the prevailing one or with loads which differ appreciably from the normal maximum. The curves of figure 5-10 include the effects of the power supply control circuits and therefore apply when the dual power supply is in the console and voltages are measured on the console 28 VDC bus. The

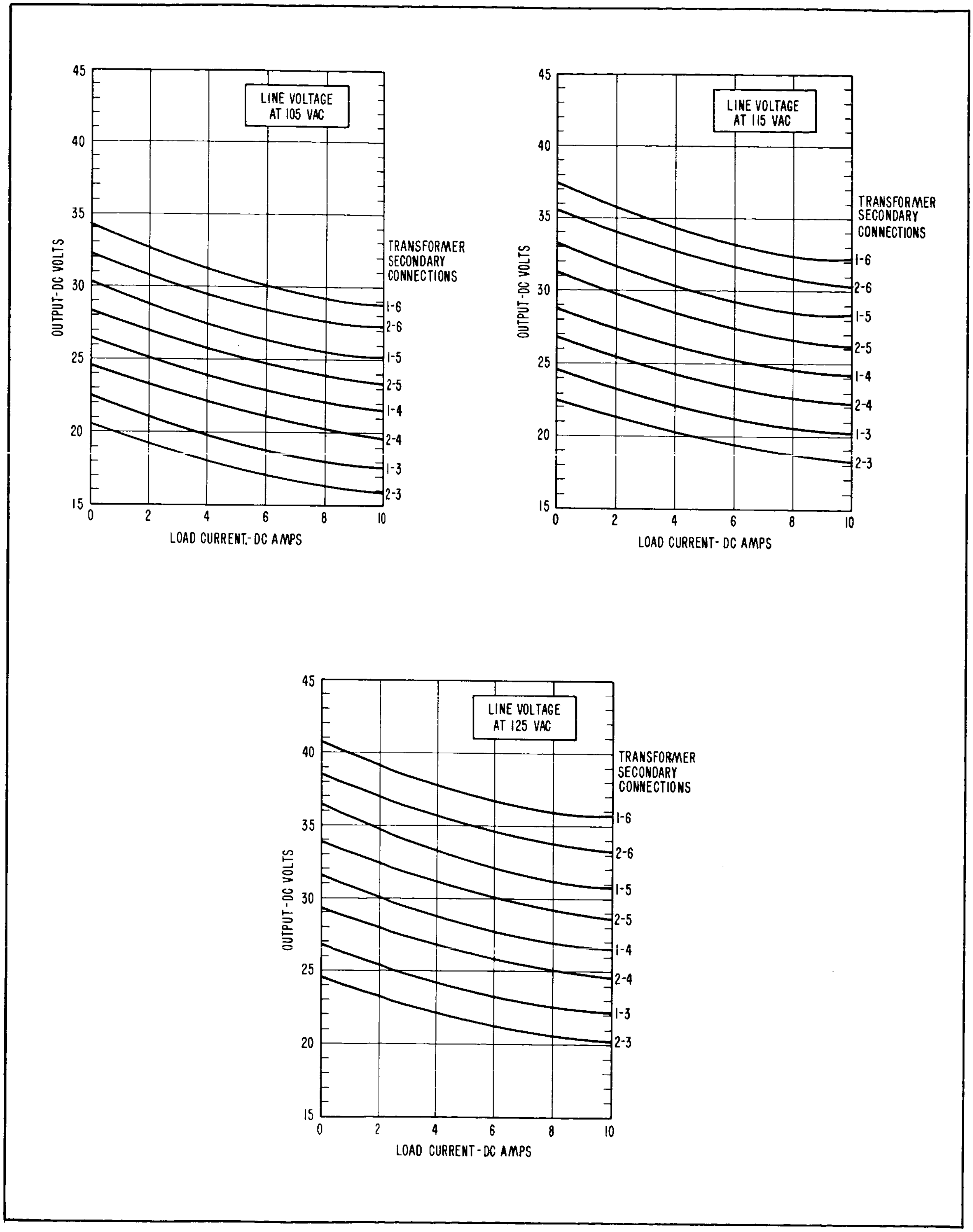


Figure 5-10. Power Supply and Control Circuit Output Voltage versus Load Current Characteristics

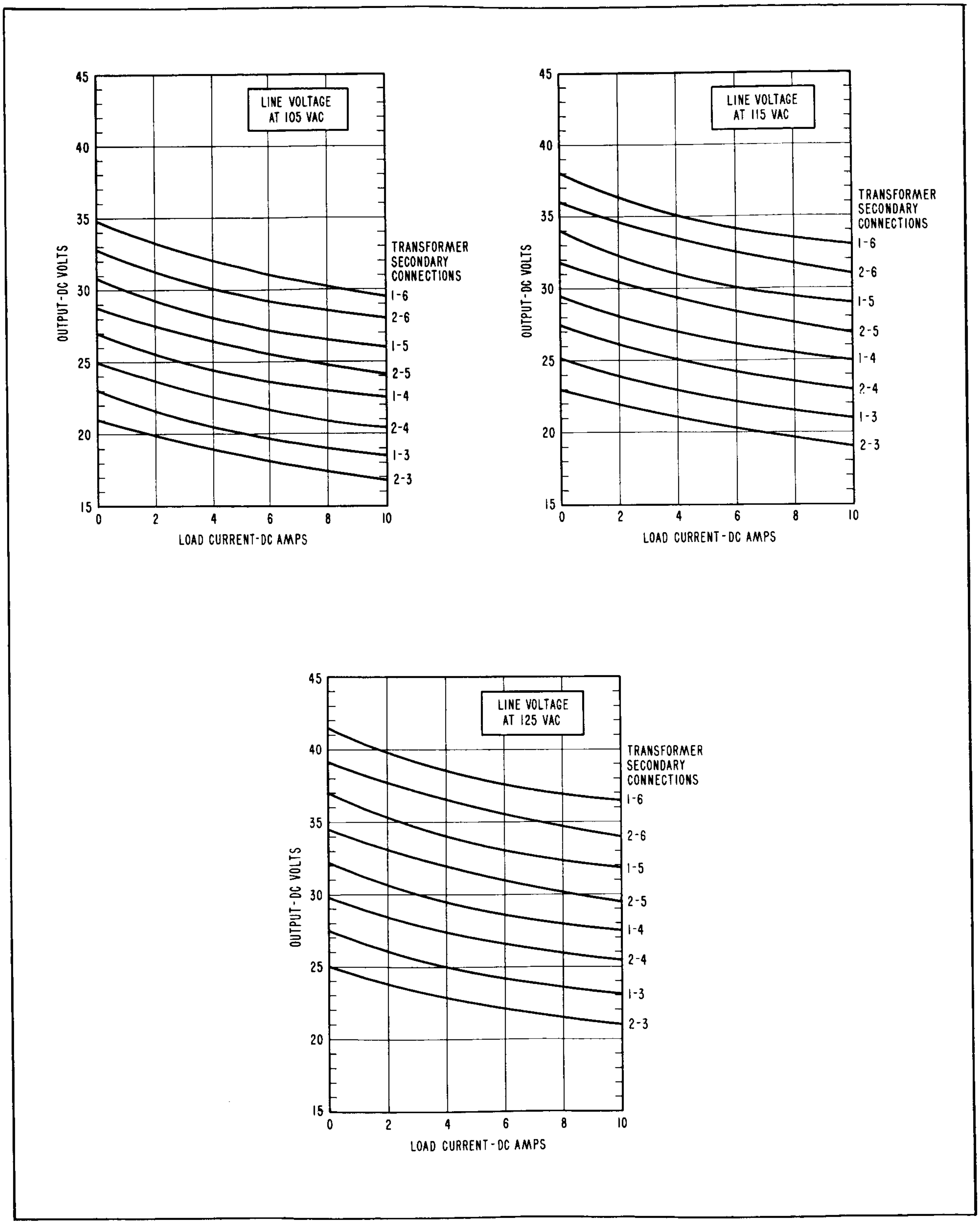


Figure 5-11. Power Supply Output Voltage versus Load Current Characteristics with Control Circuit Disconnected

curves of figure 5-11 apply when the control circuits are disconnected and voltages are measured right at the output of a filter unit (terminal board TB6203 or TB6204, terminals 3 and 2) as when the dual power supply is on the bench. For an a-c line voltage near 115 VAC, transformer secondary connections to terminal board terminals 2 and 4 should provide the proper d-c output voltage. (The maximum normal load is approximately one ampere.) For other a-c line voltages, the curves of figures 5-10 and 5-11 show the transformer secondary connections which should produce the correct output voltage. Proceed as follows to check and adjust the power supply output voltages when the dual power supply is connected to the console for normal operation. The procedure for checking and adjusting when the dual power supply is on the bench is essentially the same as the following, but the details of the on-the-bench procedure will depend on the particular test setup used:

1. Energize power supply number 1 by turning on switch S6201 on the dual power supply and depressing "28 V SUPPLY" switch S6004.

2. Apply maximum normal load to the power supply by energizing as many switches, indicators and relays as can be energized at one time.

3. Measure the voltage output of power supply number 1 between terminals 3 and 4 of terminal board TB6001 or any other convenient place on the console 28 VDC bus. (See figure 7-1.)

4. The output voltage of the power supply should be as described above (24 to 26 volts with the prevailing a-c line voltage supplied to the console). If it is not, adjust the voltage by changing on terminal board TB6201 the connections to the secondary taps of transformer T6201. By changing these connections, the d-c output voltage of the power supply can be adjusted over a range of about 14 volts in steps of approximately two volts. Moving one connecting wire between TB6201 terminals 3 and 4, 4 and 5, or 5 and 6 increases or decreases the d-c

output by about four volts; and moving the other connecting wire between TB6201 terminals 1 and 2 increases or decreases the output voltage by about two volts. (See figure 5-12.)

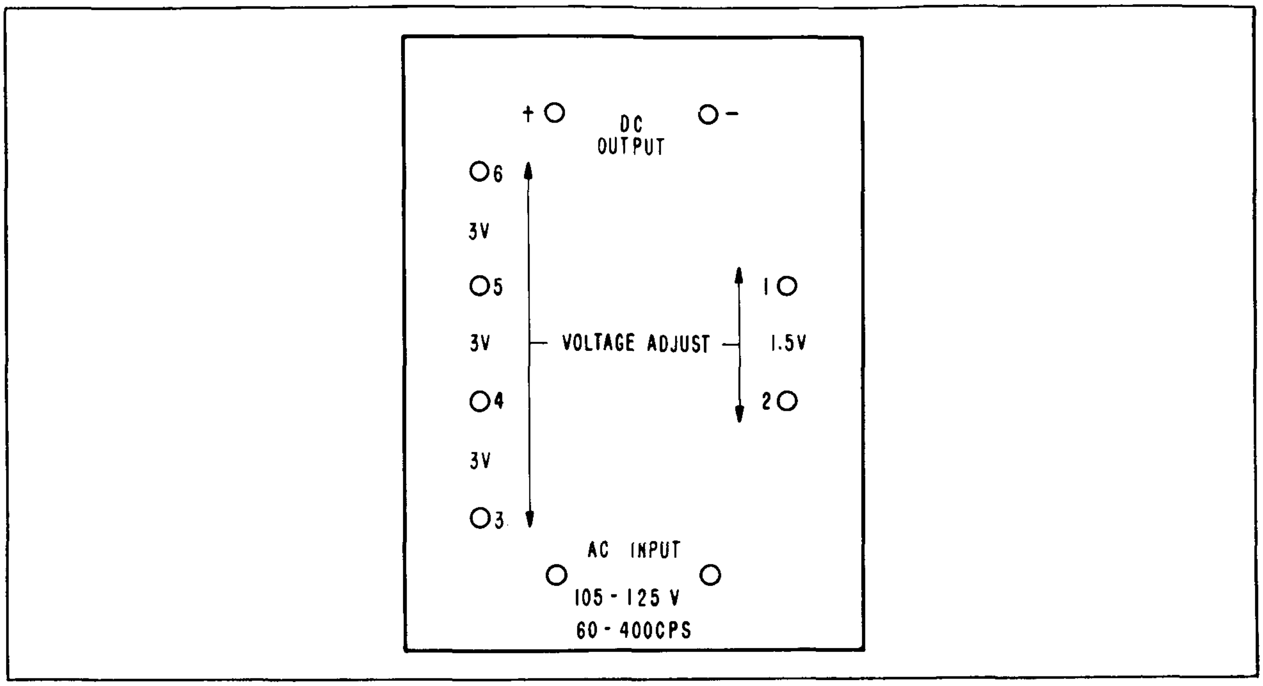


Figure 5-12. Power Supply Unit Terminal Board

5. Turn off power supply number 1 and repeat steps one through four with appropriate changes in reference designations for power supply number 2.

(b). REPAIR

Correction of a malfunction in the dual power supply can be effected by conventional trouble shooting and repair procedures. Check a-c and d-c voltages and check continuity of power transformer T6201 or T6202 and filter choke L6201 or L6202. See the dual power supply schematic and physical wiring diagrams, figures 7-3 and 7-4. For location of parts on the power supply units and filter units, see figure 5-13. Normal a-c voltages for the power transformers are shown in table 5-II. Bear in mind that two switches are in series with the primary 115 VAC power to each power supply in the dual power supply; for power supply number 1 these switches are S6201 on

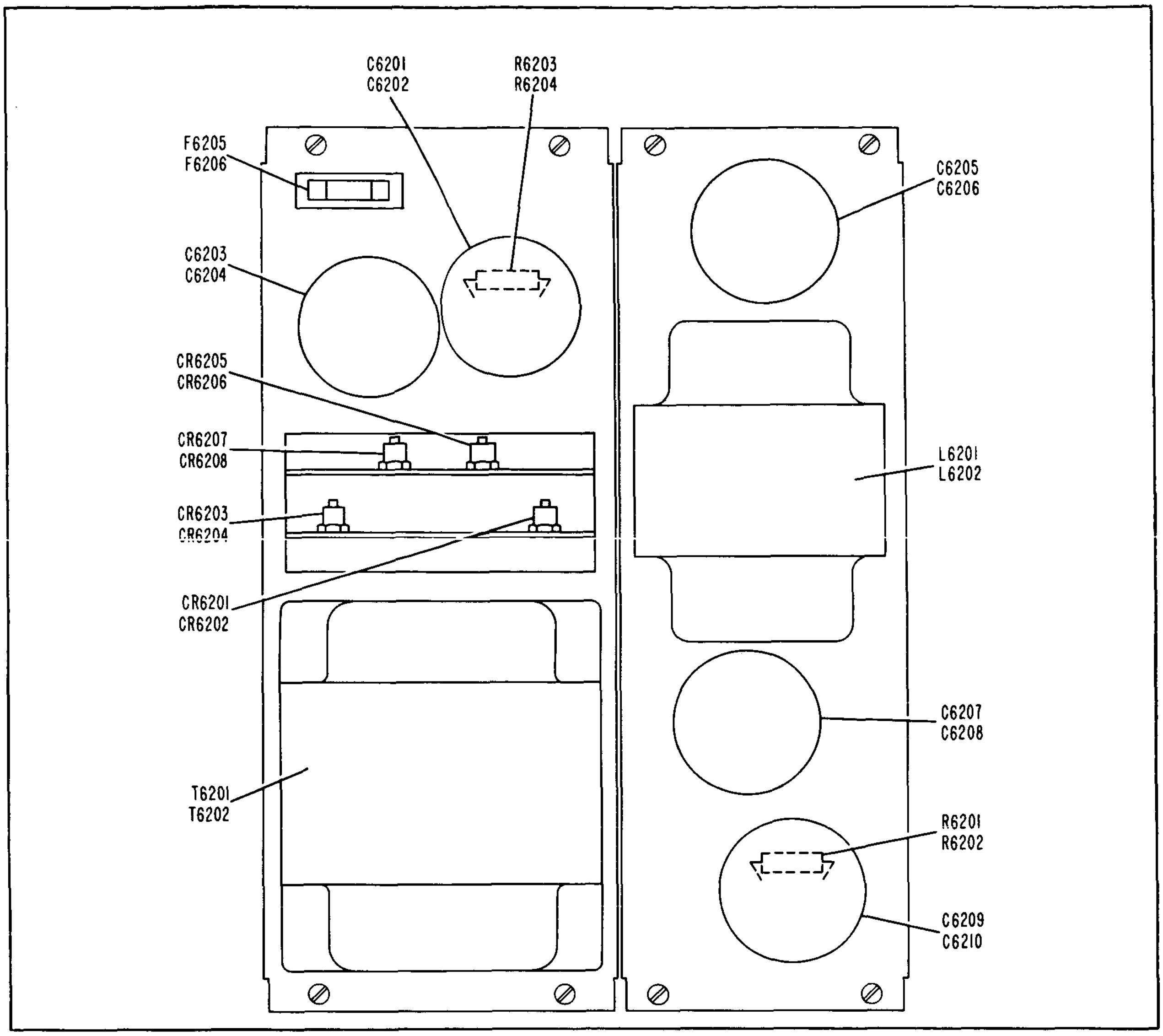


Figure 5-13. Power Supply Unit and Filter Unit, Parts Location

the dual power supply, and S6004 on the acquisition data panel; for power supply number 2 the switches are S6201 on the dual power supply and S6005 on the acquisition data panel. Bear in mind also that in addition to the fuses, F6201-F6204, on the front panel of the dual power supply, there is another fuse (F6205, F6206) on each of the power supply units (PS6201 and PS6202).

TABLE 5-II. NORMAL POWER TRANSFORMER VOLTAGES
(T6201, T6202)

Terminals (TB6201 or TB6202)	Approximate RMS Voltage
1-6	28
2-3	18
1-2	1.5
3-4	3
4-5	3
5-6	3
7-8	115

E. RELAYS

(1). All of the relays used on the acquisition data console are heremetically sealed, and no maintenance or repair is possible. When one of them becomes defective, replace it. To ascertain that a console relay is defective, check the following:

(a). Coil resistance: D-c coil resistances should be as follows:

1. K6001, K6002: 1000 ohms.
2. K6003, K6004, K6005: 200 ohms.
3. K6006, K6007, K6008: 6500 ohms.

(b). Contacts: With all power off, check continuity between normally closed contacts. With the suspected relay energized and voltage applied across the contacts, check for voltage drop across normally open contacts. There should of course be none.

(2). For detailed information on relays in the acquisition system outside the acquisition data console, refer to the applicable equipment manuals.

F. SWITCH AND INDICATOR ASSEMBLIES

For a description of acquisition data console switch and indicator assemblies and how they work, refer to paragraph 4-2.B.(3). and see figure 4-4.

(1). INDICATORS AND OPERATOR-INDICATOR UNITS

Maintenance of indicators and the operator-indicator unit portion of switch assemblies consists simply of replacing loose or defective lamps and color filters. Replacement of these items is most easily accomplished with the use of the special lamp-filter tool (Microswitch part number 15PA19).

(2). COILS

The coil portion of switch assemblies can best be checked by observing the action of the plunger. When the plunger is depressed and the coil energized, the plunger should remain securely in the depressed, or actuated, position. Also check the d-c resistance of the coil. It should be about 480 ohms.

(3). SWITCHES

The operation of the switch portion of switch assemblies can be checked by seeing whether all of its contacts make and break properly as the coil plunger is depressed and released. Faulty or intermittently faulty operation of a switch section can oftentimes be corrected by adjusting the amount of bend in the small arm which actuates the individual switch section plunger (as distinguished from the main, or coil plunger). When the operation of a switch section is faulty and cannot be corrected, the entire switch portion of the switch assembly must be replaced.

G. SYNCHRO LINE AMPLIFIER

This paragraph covers two procedures for adjusting the synchro line amplifier; one is an on-the-bench procedure whereby the amplifier can be adjusted independently of any synchros, and the other is an in-system procedure, which in some cases will be more convenient to perform or may be necessary for touching up the adjustments. Both procedures described apply to both the azimuth and elevation channels of the synchro line amplifier (the two channels are identical); thus, for complete adjustment of the amplifier, the procedure used will have to be followed twice, once for the azimuth channel and once for the elevation channel. For synchro line amplifier trouble shooting and repair procedures, refer to the applicable equipment manual.

(1). BENCH ADJUSTMENT

(a). Connect a variac (General Radio Type W10MT) to the synchro line amplifier channel which is to be adjusted. Connect the variac so that 78 VAC can be applied to the amplifier between pins C and

A-B of jack P1. (See figure 5-14.)

WARNING

Be sure to connect the neutral (synchro R2 winding) side of the 115 VAC power to pin C of jack P1 on the line amplifier. Connecting the "hot" (synchro R1 winding) side of the 115 VAC power to pin C of P1 would put 115 VAC directly on the chassis of the synchro line amplifier.

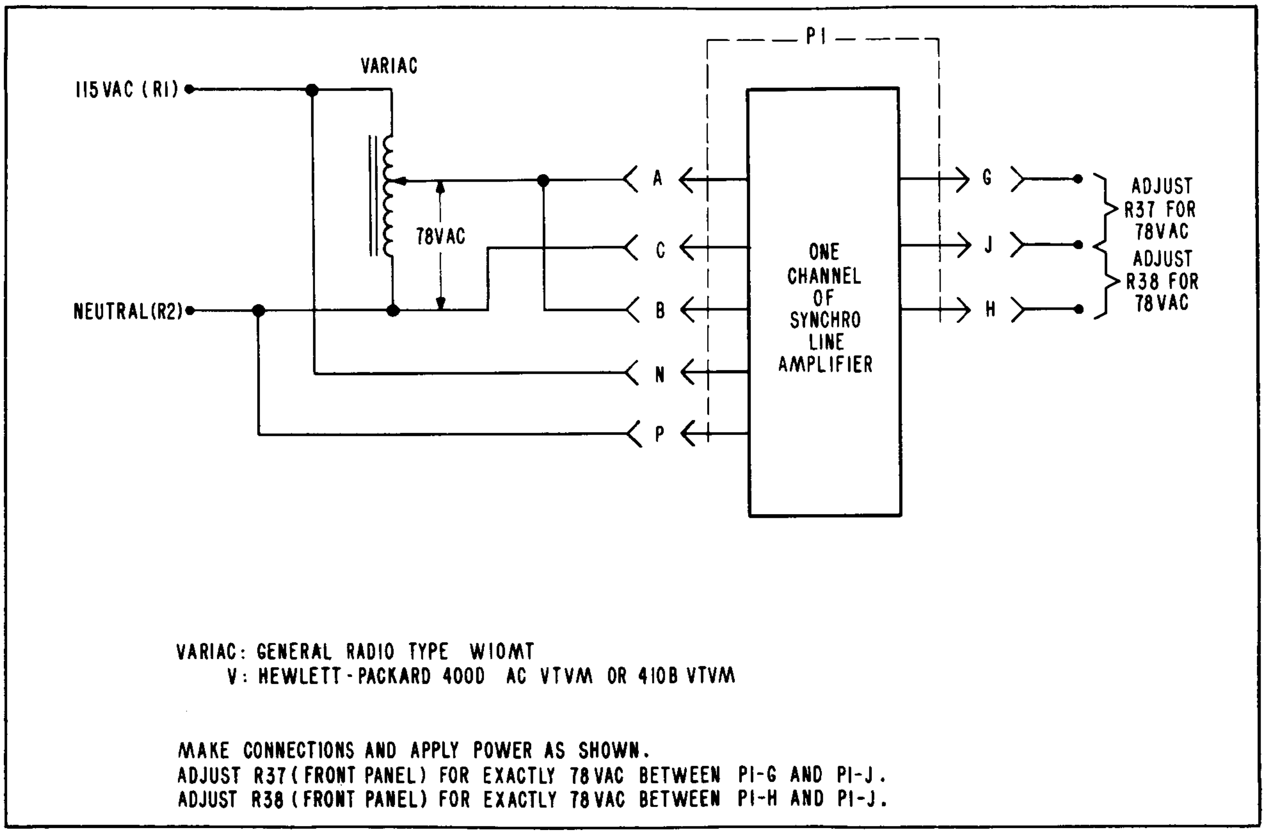


Figure 5-14. Synchro Line Amplifier, Bench Adjustment Setup

(b). Before the synchro line amplifier is turned on (by means of switch S1 on the front panel), adjust the output of the variac for 78 VAC.

(c). Turn on switch S1 of the amplifier channel to be adjusted and allow about 10 minutes warm-up time before proceeding with the adjustment.

(d). With a voltmeter (Hewlett-Packard 400D AC VTVM or 410B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(e). Adjust calibration potentiometer R37 (on the front panel of the line amplifier, figure 3-3) for exactly 78 VAC on the voltmeter.

(f). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier, figure 3-3) for exactly 78 VAC between these pins.

(g). To balance the amplifier output precisely, reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 and R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Although there is little potential difference between pins G and H of P1 both of these pins are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

(2). <u>IN-SYSTEM ADJUSTMENT</u>

In-system adjustment of the synchro line amplifier consists of connecting a synchro transmitter to the input of the amplifier and adjusting the amplifier so that its output is the same as the output of the synchro transmitter. Any synchro transmitter which is normally connected to the synchro line amplifier can be used as a reference for adjustment, and in some cases, the best system performance may be obtained if the adjustment is made with a normal load on the amplifier; i.e., with normal, operating connections made to the amplifier output. If difficulty is encountered in obtaining proper system alignment, the amplifier should be adjusted with normal load on the output and with no load on the output to see which method gives the better results.

(a). Apply power by means of switch S1 to the synchro line amplifier channel to be adjusted and energize the synchros connected to the line amplifier. Allow the amplifier to warm up for about 10 minutes.

(b). Set the synchro transmitter which is connected to the input of the amplifier to exactly zero degrees.

Note

When using this procedure, the accuracy of the synchro line amplifier adjustment is dependent on the accuracy of the synchro transmitter used. Therefore, be sure that the synchro transmitter has been properly adjusted. (Refer to paragraph 5-4.B.)

(c). With a voltmeter (Hewlett-Packard 400D AC VTVM or 410B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(d). Adjust calibration potentiometer R37 (on the front panel of the line amplifier) for exactly 78 VAC on the voltmeter.

(e). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier) for exactly 78 VAC between these pins.

(f). Reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 or R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Pins G and H of P1 are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

5-5. LUBRICATION

Table 5-III is a lubrication schedule for all of the equipment in the acquisition system except the TLM-18. For the lubrication schedule for the TLM-18, see the

applicable equipment manual.

5-6. SPECIAL TOOLS

The only special tool required for maintenance of the acquisition system is the lamp-filter tool (Microswitch part number 15PA19, Bendix Radio part number A683836-1). This tool, shown in figure 5-15, is used for removal and replacement of the lamps and color filters in the indicators and switch assemblies on the acquisition data console.

5-7. TEST EQUIPMENT

Each piece of test equipment required for maintenance of the acquisition system is listed in table 5-IV along with a brief description of its application.

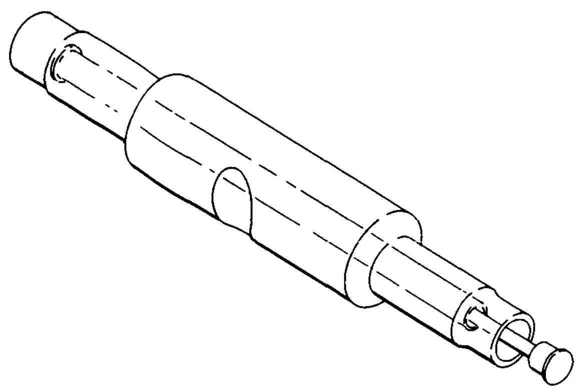


Figure 5-15. Lamp-Filter Tool

TABLE 5-III. LUBRICATION SCHEDULE

Lubrication Point	Procedure	Lubricant	Frequency
18-64 SYNCHRO SPEED CONVERTER			
Servo gear train.	Remove cover of gear box and clean and grease gears. Refer to equipment manual.	High grade cup grease such as MIL-G-3278A or ANG-25.	Annually
SYNCHRO REMOTING TRANSMITTER-RECEIVER			
Azimuth and elevation servo encoder assembly gear trains.	Grease gears. Refer to equipment manual.	High grade cup grease such as MIL-G-3278A or ANG-25.	Semi-annually
SYNCHRO REMOTING TWO-CHANNEL RECEIVER			
No lubrication required.		-	-
ACQUISITION DATA CONSOLE			
No lubrication required.		-	-
SYNCHRO LINE AMPLIFIER			
No lubrication required.		-	-

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS

Equipment	Manufacturer	Model	Application
Oscilloscope	Hewlett-Packard Company	130B	General waveform observation and voltage measurements.
Oscilloscope	Tektronix, Incorporated	545A	General waveform observation and voltage measurements.
Dual-Trace Calibrated Preamplifier	Tektronix, Incorporated	Type CA	Oscilloscope plug-in unit used with Tektronix 545A.
Plug-In Preamplifier	Tektronix, Incorporated	Type L	Oscilloscope plug-in unit used with Tektronix 545A.
Viewing Hood	Tektronix, Incorporated	H510	Aid in viewing of oscilloscope screens.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio P/N-A683940-1)	Support and transportation of oscilloscopes and storage of plug-in units.
United Regulated Power Supply	General Radio Company	1201-B	General bench testing of assemblies. Provides a source of a-c heater voltage at 6.3 VAC and 4A, and d-c plate power at 300 VDC and 70 MA.
Regulated Power Supply	Lambda Electronics Corporation	71	General purpose power supply with following outputs: 0-500 VDC, 0-200 MA; 0-200 VDC, 0-50 VDC, Bias; and 6.5 VAC, 5A.
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	High resolution power supply with output of 0 to 555 volts and 0 to 300 MA for calibration purposes.
Square Wave Generator	Tektronix, Incorporated	Type 105	Alignment and testing of oscilloscopes and associated plug-in units.
Signal Generator	Boonton Radio Corporation	225-A	Test and alignment of receivers, sensitivity and bandwidth measurements in the 10- to 500-MC frequency range.
HF Signal Generator	Hewlett-Packard Company	606-A	General purpose signal generator with a frequency range of 50 KC to 65 MC.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Transfer Oscillator	Hewlett-Packard Company	540-B	Test and alignment of signal generators up to 2000 MC
Wide Range Oscillator	Hewlett-Packard Company	200 CD	Test and adjustment of circuits in the range of 5 CPS to 600 KC.
Unit Oscillator	General Radio Company	1209-BL	Test and alignment of receivers, sensitivity and bandwidth measurements in the 180- to 600-MC range.
Universal EPUT and Timer	Beckman Instruments, Inc.	7370	Precision frequency measurements from 10 CPS to 11.5 MC.
Frequency Converter	Beckman Instruments, Inc.	7570 through 7573	Used with Beckman EPUT and timer to measure frequencies up to 220 MC.
Power Output Meter	The Daven Company	OP-962	Audio frequency power measurement in the power range of 0.1 milliwatt to 100 watts.
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	Precision d-c measurements with 0.5 per cent accuracy over the range of .01 to 500 volts.
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	General a-c, d-c, and r-f voltage measurements and resistance measurements.
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	Accurate a-c voltage measurements from .001 volt to 300 volts over a frequency range of 10 CPS to 4 MC.
Volt-Ohm-Milliammeter	Triplett-Electrical Instrument Company	630-PL	General voltage, current and resistance measurements (20,000 ohms/volt).
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	Measure total distortion of any frequency from 20 to 20,000 CPS.
RF Detector	Telonic Industries, Incorporated	XD-3	Detect output of r-f preamplifiers and i-f amplifiers in the 0.5- to 1000-MC range.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Tube Analyzer	Triplett Electrical Instrument Company	3444	Tube checks.
Variac	General Radio Company	W10MT	General purpose voltage source with output of 0-115 VAC at 10 amps.
Attenuator Pad	Telonic Industries, Incorporated	TGC-50	Matching, isolation and general bench test applications in the 0.5- to 1000-MC frequency range.
Miscellaneous Cables and Accessories	—	—	—

SECTION VI
PARTS LIST

6-1. GENERAL

This section comprises lists of the parts which make up the acquisition data console and the TLM-18 acquisition bus display panel. The lists are as follows:

Equipment	Parts List Table	Part Location Illustration
Acquisition Data Console, P/N R651498-1	6-I	Figure 7-2
Dual Power Supply, P/N R651470-2	6-II	Figures 7-4, 5-13
Intercom Panel, P/N N654990-5	6-III	-
TLM-18 Acquisition Bus Display Panel, P/N L653979-1	6-IV	Figure 3-5

6-2. OTHER EQUIPMENT

For information on other equipment in the acquisition system, refer to the applicable equipment manuals, listed in table 1-II.

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
B6001	Synchro Receiver	N681819-3	-	1
B6002	Synchro Receiver	N681819-2	-	1
B6003	Synchro Receiver	N681819-3	-	1
B6004	Synchro Receiver	N681819-2	-	1
B6005	Synchro Receiver	N681819-3	-	1
B6006	Synchro Receiver	N681819-2	-	1
B6007	Synchro Receiver	N681819-3	-	1
B6008	Synchro Receiver	N681819-2	-	1
B6009	Synchro Receiver	N681819-2	-	1
B6010	Synchro Receiver	N681819-3	-	1
	Synchro Transmitter Assembly, consisting of:	N654986-1	-	2
B6011, B6012	Synchro Transmitter	N683953-1	-	1
	Spring Compression	A689693-1	-	1
	Bushing, Polyamide	A689682-1	-	1
	Bushing, Polyamide	A689683-1	-	1
B6013, B6014	Synchro Receiver (refer to note 1)	-	-	2
CR6001	Diode, Silicon	A683966-1	-	1
CR6002	Diode, Silicon	A683966-1	-	1
CR6003	Diode, Zener (18 volts)	A683971-1	-	1
CR6004	Diode, Zener (18 volts)	A683971-1	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6001, DS6002	Lamp, GE327	-	AN3140-327	2
DS6003, DS6004	Not Used	-	-	-
DS6005 through DS6034	Lamp, GE327	-	AN3140-327	29
DS6035, DS6036	Lamp, DIALCO #39	A683817-3	-	2
J6011, J6012, J6013	Phone Jack, Closed Contact, Switch Craft, Type JJ-089	-	-	3
K6001, K6002	Relay, Sensitive, 1000 ohm, 4.5 MA, (DPDT)	A683968-1	-	2
K6003 through K6005	Relay, 28 VDC 6PDT	A683969-3	-	3
K6006 through K6008	Relay, 28 VDC, 1.5 MA, SPDT, Elgin Advance Relay Co., P/N SO/IC/6500D	A696894	-	3
P6001 through P6010	Connector	-	MS3106A-14S-2S	10
P6011, P6012	Connector	-	MS3106R-22-14S	2
R6001	Not Used	-	-	-

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
R6002 through R6004	Potentiometer, 10K ohms, 2W	-	RV4LAXSA103B	3
R6005 through R6007	Resistor, 5100 ohms, 1W, ±5%	-	RC32GF512J	3
S6001	Switch Assembly, consisting of:			
	Operator Indicator Unit w/coil	A681843-3	-	1
	Lamps, DS6007, DS6008	-	-	2
	Switch, 4PDT Momentary	A681845-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
S6002	Switch Assembly, consisting of:			
	Operator Indicator Unit w/coil	A681843-3	-	1
	Lamps, DS6015, DS6016	-	-	2
	Switch, 4PDT Momentary	A681845-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
S6003	Switch Assembly, consisting of:			
	Operator Indicator Unit w/coil	A681843-3	-	1
	Lamps, DS6023, DS6024	-	-	2
	Switch, 4PDT Momentary	A681845-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
S6004	Switch Assembly, consisting of:			
	Operator Indicator Unit w/coil	A681843-3	-	1
	Lamps, DS6027, DS6028, DS6029, DS6030	-	-	4

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
S6004 (Cont.)	Switch, 3PDT	A681845-4	-	1
	Display Screen	A681843-2	-	1
	Color Filter (green)	A683911-3	-	2
	Color Filter (red)	A683911-1	-	2
S6005	Switch Assembly, consisting of:			
	Operator Indicator Unit w/coil	A681843-3	-	1
	Lamps, DS6031, DS6032, DS6033, DS6034	-	-	4
	Switch 3PDT	A681845-4	-	1
	Display Screen	A681848-2	-	1
	Color Filter (green)	A683911-3	-	2
	Color Filter (red)	A683911-1	-	2
S6006, S6007	Switch, 4PDT (refer to note 1)	-	-	2
T6001, T6002	Transformer (refer to note 1)	-	-	2
TB6001	Terminal Board	L678289-8	-	1
TB6002 through TB6017	Terminal Board	L678288-8	-	16
TB6018	Terminal Board	L678288-20	-	1
TB6019, TB6020	Terminal Board (refer to note 1)	-	-	2
X6001	Indicator Unit	A683961-2	-	1
	Lamps, DS6001, DS6002	-	-	2
	Color Filter (yellow)	A683911-2	-	2
	Display Screen	A681848-2	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
X6002	Indicator Unit	A683961-2	-	1
	Lamps, DS6005, DS6006	-	-	2
	Color Filter (yellow)	A683911-2	-	2
	Display Screen	A681848-2	-	1
X6003	Indicator Unit	A683961-2	-	1
	Lamps, DS6009, DS6010	-	-	2
	Color Filter (yellow)	A683911-2	-	2
	Display Screen	A681848-2	-	1
X6004	Indicator Unit	A683961-2	-	1
	Lamps, DS6011, DS6012, DS6013, DS6014	-	-	4
	Color Filter (green)	A683911-3	-	2
	Color Filter (red)	A683911-1	-	2
	Display Screen	A681848-4	-	1
X6005	Indicator Unit	A683961-2	-	1
	Lamps, DS6017, DS6018, DS6019, DS6020	-	-	4
	Color Filter (green)	A683911-3	-	2
	Color Filter (red)	A683911-1	-	2
	Display Screen	A681848-4	-	1
X6006	Indicator Unit	A683961-2	-	1
	Lamps, DS6021, DS6022	-	-	2
	Color Filter (red)	A683911-1	-	2
	Display Screen	A681848-2	-	1
X6007	Indicator Unit	A683961-2	-	1
	Lamps, DS6025, DS6026	-	-	2
	Color Filter (green)	A683911-3	-	2
	Display Screen	A681848-2	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651498-1 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
XDS6035	Pilot Light Assembly	A683815-1	-	1
XDS6036	Pilot Light Assembly	A683815-1	-	1
XS6001 through XS6005	Operator Indicator Unit w/coil	A681843-3	-	5
P6201	Connector	-	MS3106R-18-12S	1
P6202	Connector	-	MS3106R-20-7S	1
-	Intercom Panel	N654990-5	-	1
-	Synchro Line Amplifier, Milgo P/N 1007-10B	A683820-1	-	1
-	Dual Power Supply	R651470-2	-	1
-	Telephone Jack, WECO P/N 238A	A683777-1	-	5
-	Handwheel	C294673-1	-	2
-	Barrier Strips (used with indicator units and switch assemblies)	A681860-2	-	22
	Note 1: The noted components are part of the HF antenna positioning systems. For information on them, refer to the applicable equipment manual, listed in table 1-II.			

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6201	Lamp, NE-51	C221315-1	-	1
F6201 through F6204	Fuse	C221603-502	-	4
FL6201	Filter, Dressen-Barnes Model 21-105	A681997-1	-	1
C6205	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6207	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6209	Capacitor, 50 WVDC, 4000 μf	-	-	1
L6201	Choke, Dressen-Barnes 512910	-	-	1
R6201	Resistor, ohmite, 600 ohm, 5W	-	-	1
FL6202	Filter, Dressen-Barnes Model 21-105	A681997-1	-	1
C6206	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6208	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6210	Capacitor, 50 WVDC, 4000 μf	-	-	1
L6202	Choke, Dressen-Barnes 512910	-	-	1
R6202	Resistor, Ohmite, 600 ohm, 5W	-	-	1
J6201	Receptacle, Box	-	MS3102R-18-12P	1
J6202	Receptacle, Box	-	MS3102R-20-7P	1
PS6201	Power Supply, Dressen-Barnes Model 21-105	A681999-3	-	1
C6201	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6203	Capacitor, 50 WVDC, 4000 μf	-	-	1
CR6201	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
CR6203	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6205	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6207	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
F6205	Fuse, 10 amp.	-	-	1
T6201	Transformer, Dressen-Barnes 511721	-	-	1
PS6202	Power Supply, Dressen-Barnes Model 21-103	A681999-3	-	1
C6202	Capacitor, 50 WVDC 4000 μf	-	-	1
C6204	Capacitor, 50 WVDC 4000 μf	-	-	1
CR6202	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6204	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6206	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6208	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
F6206	Fuse, 10 amp.	-	-	1
T6202	Transformer, Dressen-Barnes 511721	-	-	1
XDS6201	Light, Indicator	C221313-7	-	1
XF6201 through XF6204	Post, Fuse, 3 AG	A683967-1	-	4

TABLE 6-III. LIST OF REPLACEABLE ELECTRICAL PARTS FOR INTERCOM PANEL, P/N N654990-5

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6401	Buzzer, WECO Part Number 7F-42	A683505-1	-	1
R6401	Dual Potentiometer, WECO Part Number KS13754	A683378-1	-	1
Z6401 through Z6404	Key	A683775-1	-	4
-	Telephone Dial 6401, WECO Part Number 6L-41	A683776-1	-	1
-	Knob	C294634-1	-	1
	ASSOCIATED PARTS			
	Connector and cable assy.	A683543-1	-	4
	Connector	A683542-1	-	1

TABLE 6-IV. LIST OF REPLACEABLE ELECTRICAL PARTS FOR TLM-18 ACQUISITION BUS DISPLAY PANEL, P/N L653979-1

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
B1	Synchro Receiver	N681819-3	-	1
B2	Synchro Receiver	N681819-2	-	1

SECTION VII
MAINTENANCE DRAWINGS

7-1. GENERAL

The drawings included in this section are listed below. It should be noted that those schematics which show connections or circuits involving two or more separate pieces of equipment are not in all cases complete in regard to the internal circuits of the equipment. For complete internal circuits, see the schematics of the individual pieces of equipment. The schematics of individual pieces of equipment are included in this section or in the individual equipment manuals, listed in table 1-II.

NOTES—
1. ADD 600V TO ALL REFERENCE DESIGNATIONS IN THIS UNIT EXCEPT SYNCHRO LINE AMPLIFIER.
2. ALL RELAYS AND SWITCHES SHOWN IN UNENERGIZED POSITION.
3. REAR VIEW OF SWITCHES S1 THROUGH S5.

Figure 7-1. Acquisition Data Console, Schematic Diagram

NOTES:

1. ADD 6000 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT EXCEPT SYNCHRO LINE AMPLIFIER.
2. ALL WIRES BREAKING OUT OF CABLES TO BE ONE INCH LONGER THAN NECESSARY WITH EXCESS WIRE DRESSED IN A NEAT LOOP ADJACENT TO TERMINALS.
3. UNLESS OTHERWISE SPECIFIED, ALL WIRES ARE #18 WHITE.
4. SECTION REFERENCE DESIGNATIONS OF SWITCHES S1 THROUGH S5 ARE AS FOLLOWS:

TOP

NO NC C

A

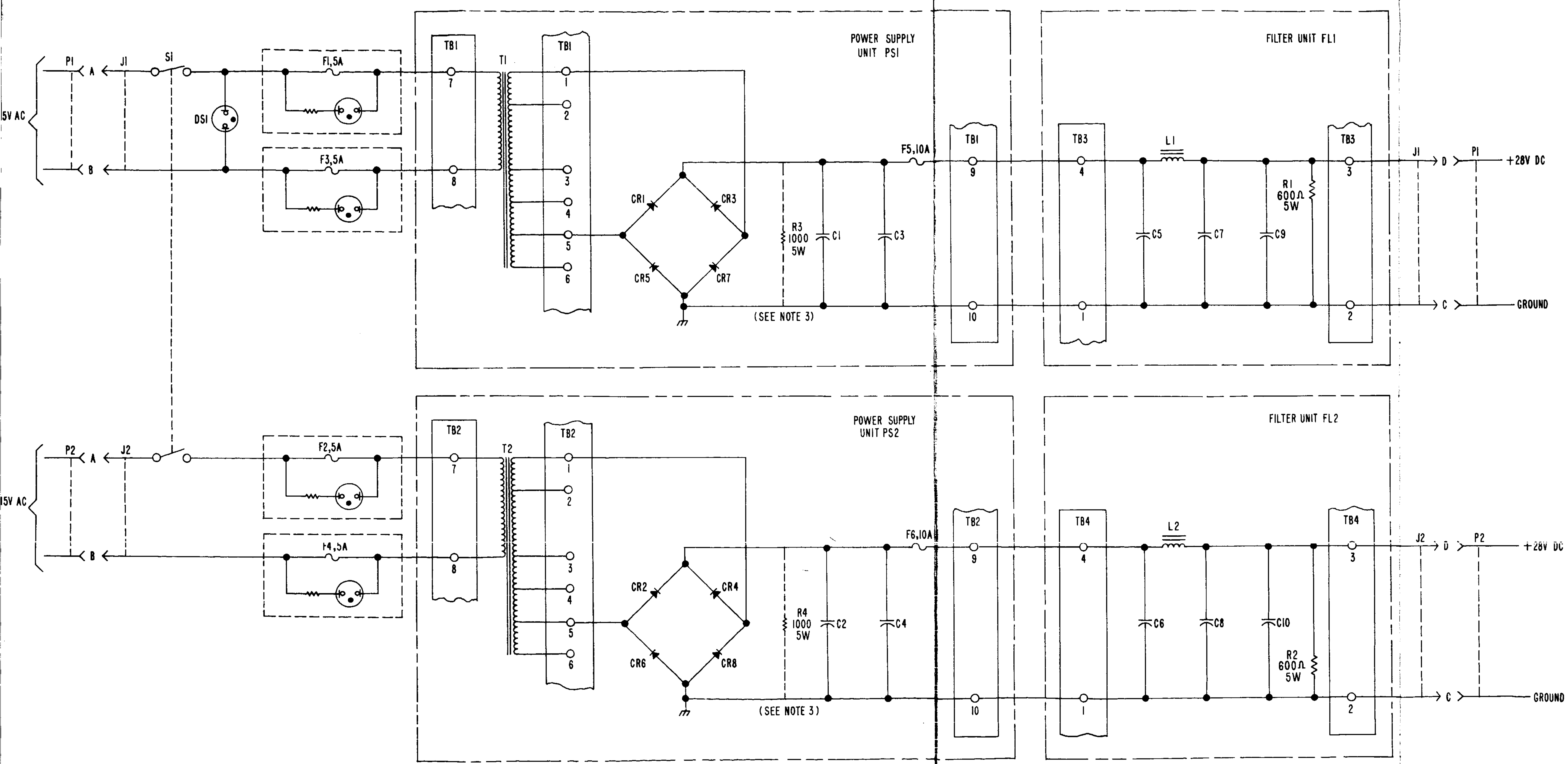
B

C

D

BOTTOM

Figure 7-2. Acquisition Data Console, Physical Wiring Diagram



NOTES:

1. ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.
2. ALL CAPACITORS ARE 4000 UF 50VDC.
3. BLEEDER RESISTORS R3 AND R4 NOT USED ON SOME MODELS.

Figure 7-3. Dual Power Supply, Schematic Diagram

NOTE:
ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.

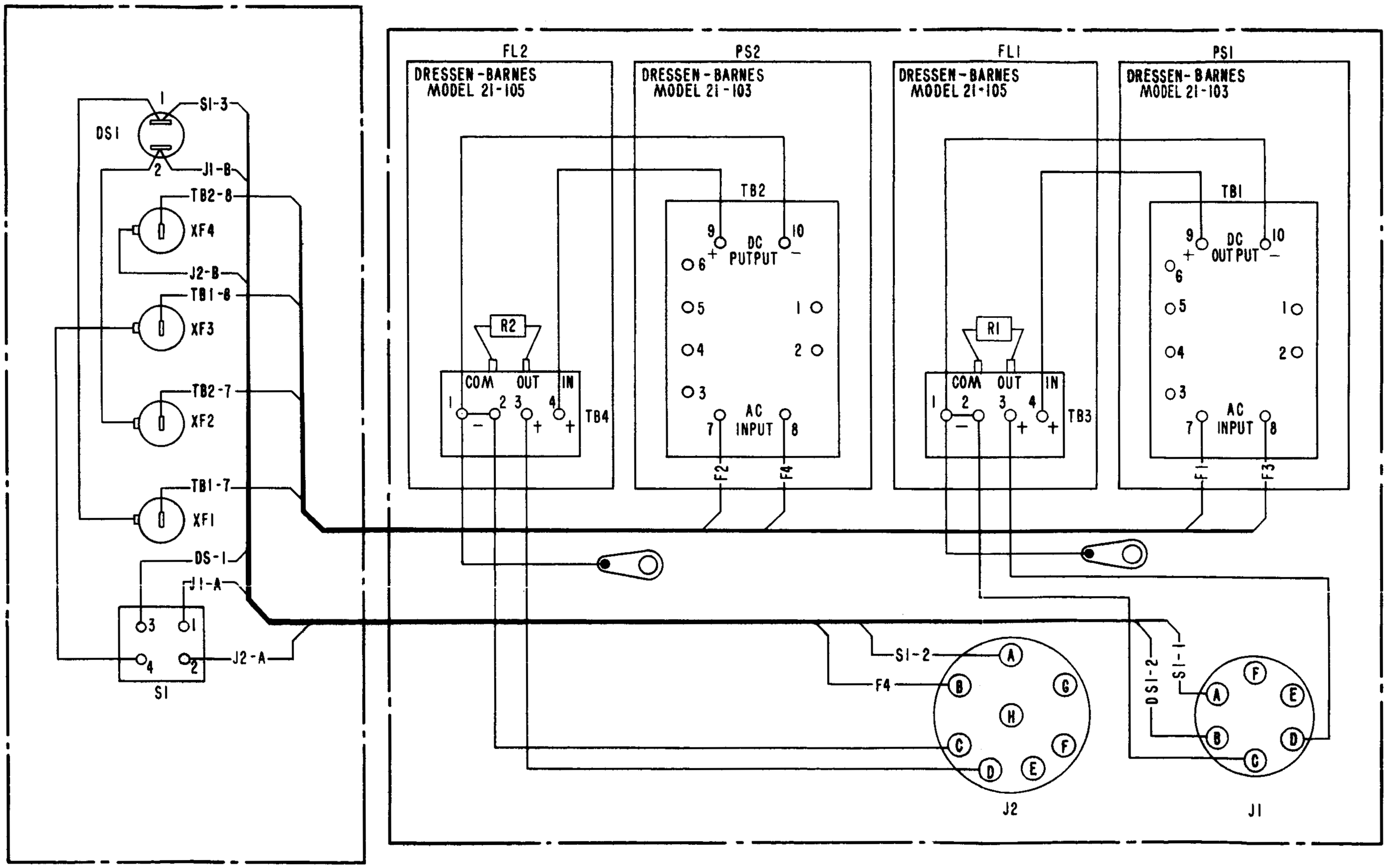


Figure 7-4. Dual Power Supply, Physical Wiring Diagram

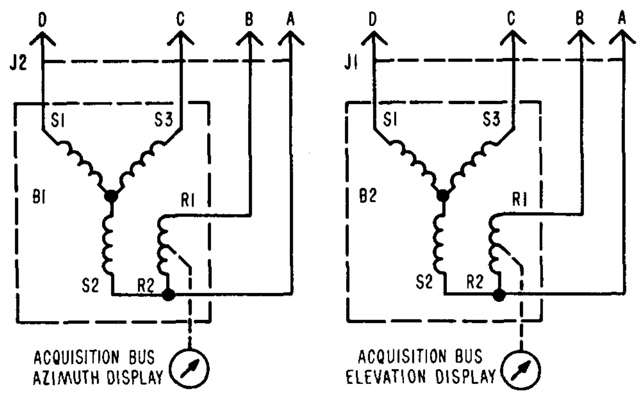


Figure 7-5. TLM-18 Acquisition Bus Display Panel, Schematic Diagram

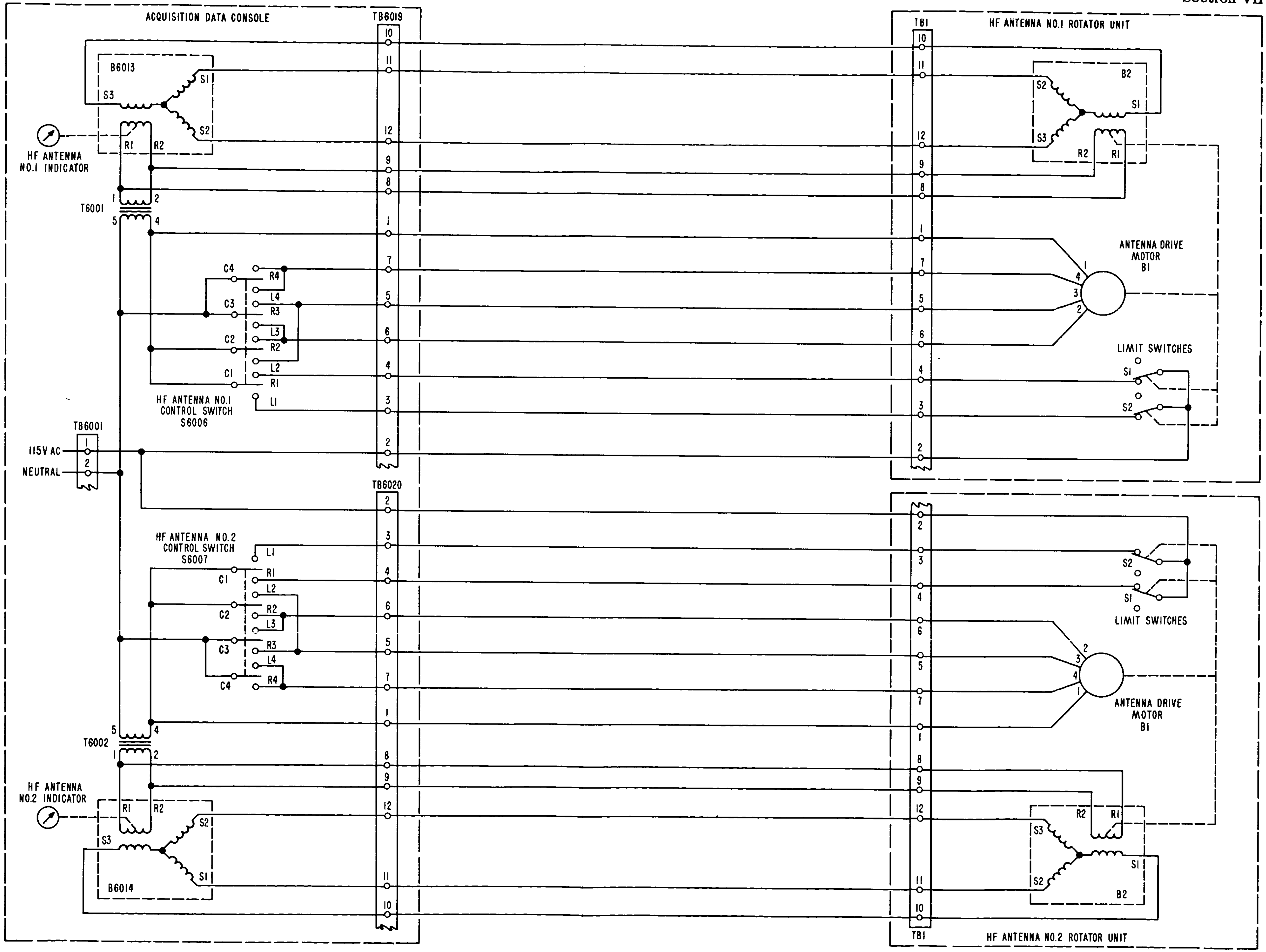


Figure 7-6. HF Antenna Positioning System, Schematic Diagram

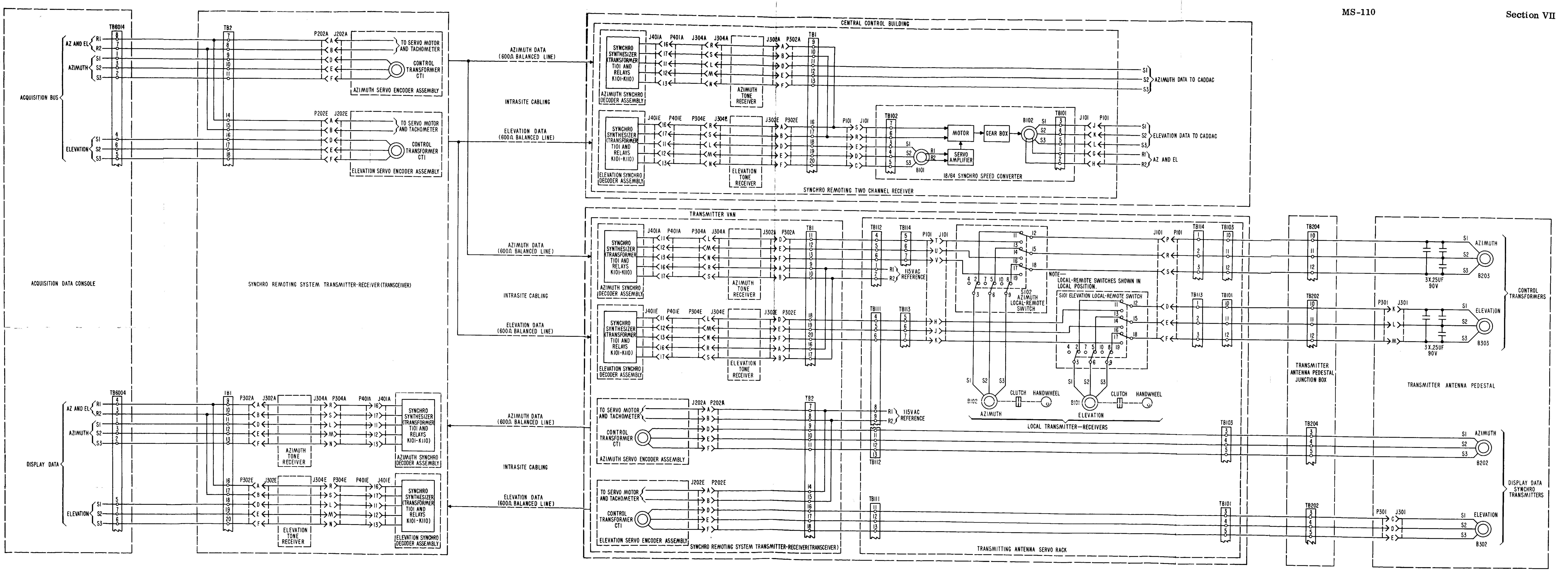


Figure 7-7. Synchro Circuit Connections between Acquisition Data Console, CADDAC, and Voice and Command Transmitting Antenna, Schematic Diagram

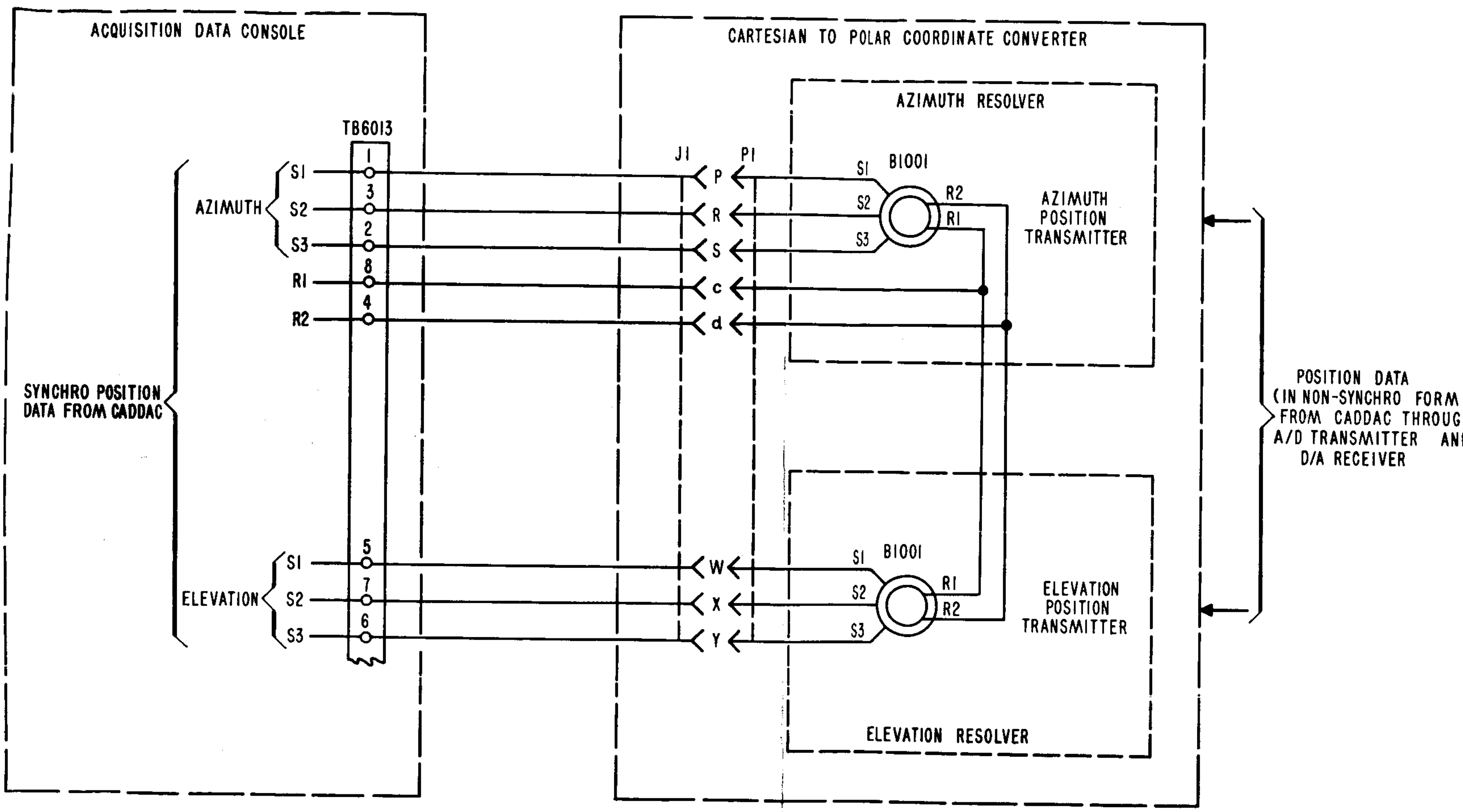
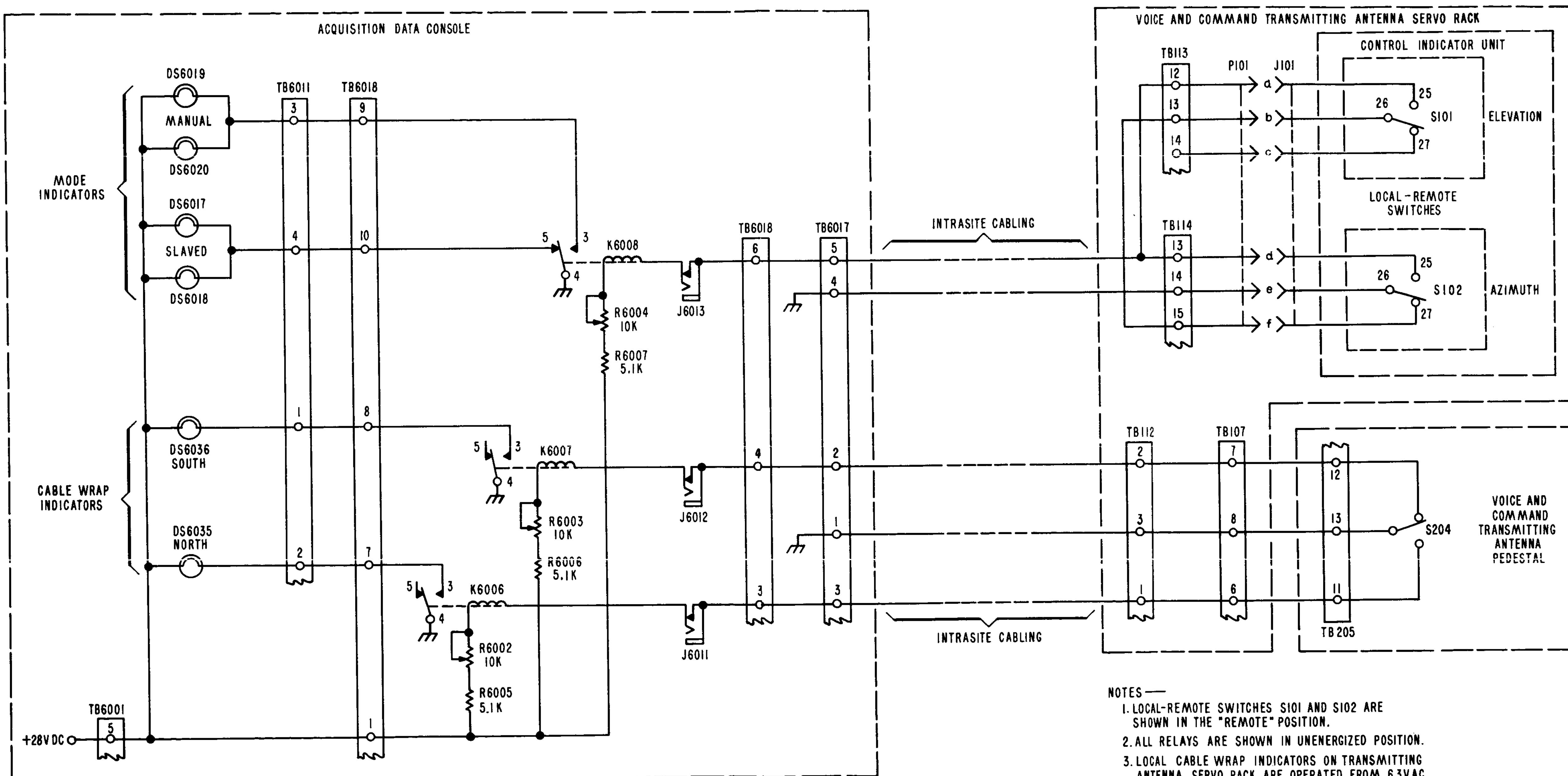


Figure 7-8. Synchro Circuit Connections between Acquisition Data Console and C/P Converter, Schematic Diagram



NOTES—

1. LOCAL-REMOTE SWITCHES S101 AND S102 ARE SHOWN IN THE "REMOTE" POSITION.
2. ALL RELAYS ARE SHOWN IN UNENERGIZED POSITION.
3. LOCAL CABLE WRAP INDICATORS ON TRANSMITTING ANTENNA SERVO RACK ARE OPERATED FROM 6.3VAC BY SWITCH S203. THE LOCAL INDICATOR CIRCUIT IS INDEPENDENT OF THAT SHOWN ON THIS DRAWING. REFER TO EQUIPMENT MANUAL.

Figure 7-10. D-c Indication Circuits from Voice and Command Transmitting Antenna to Acquisition Data Console, Schematic Diagram

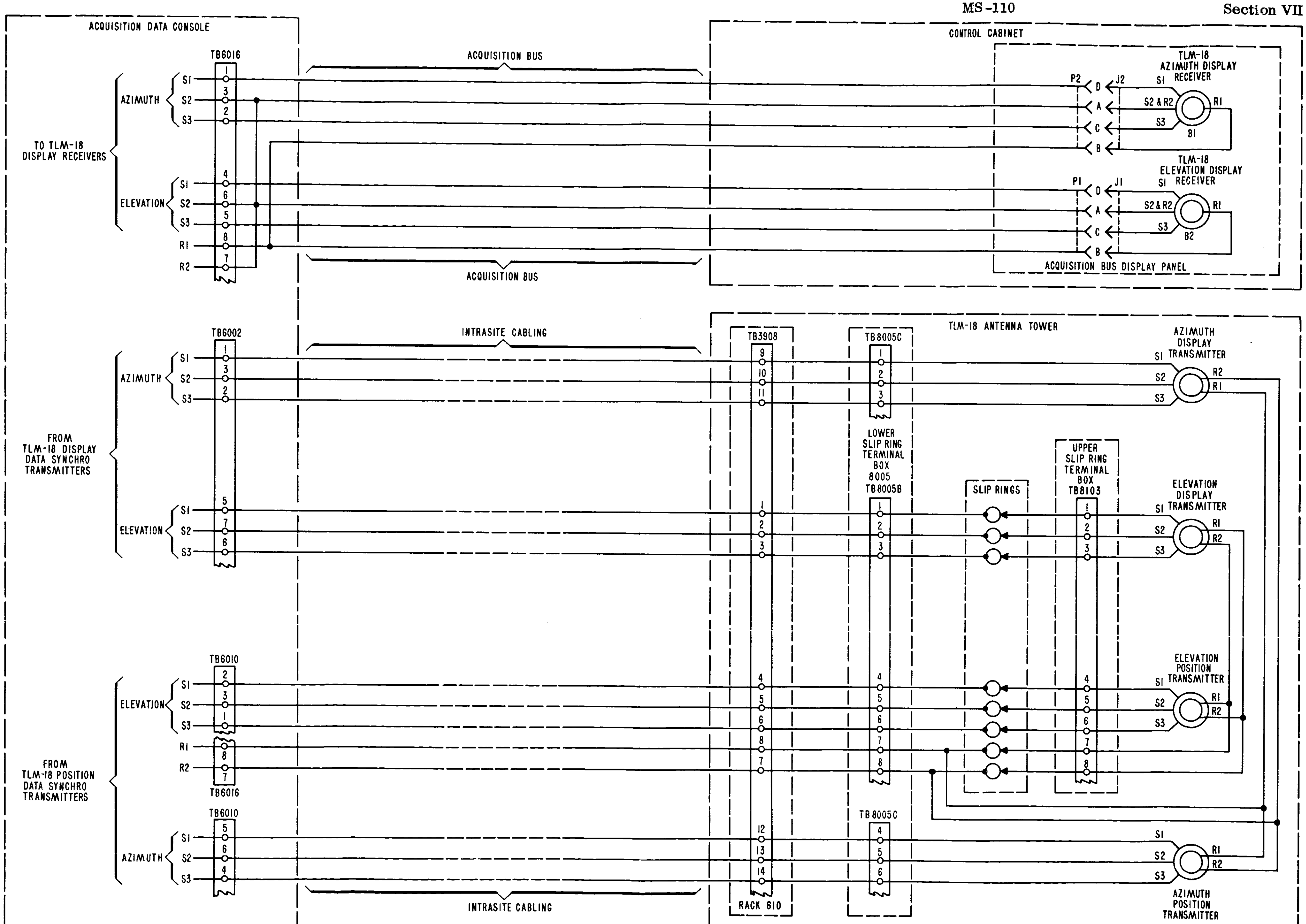


Figure 7-9. Synchro Circuit Connections between Acquisition Data Console and TLM-18, Schematic Diagram

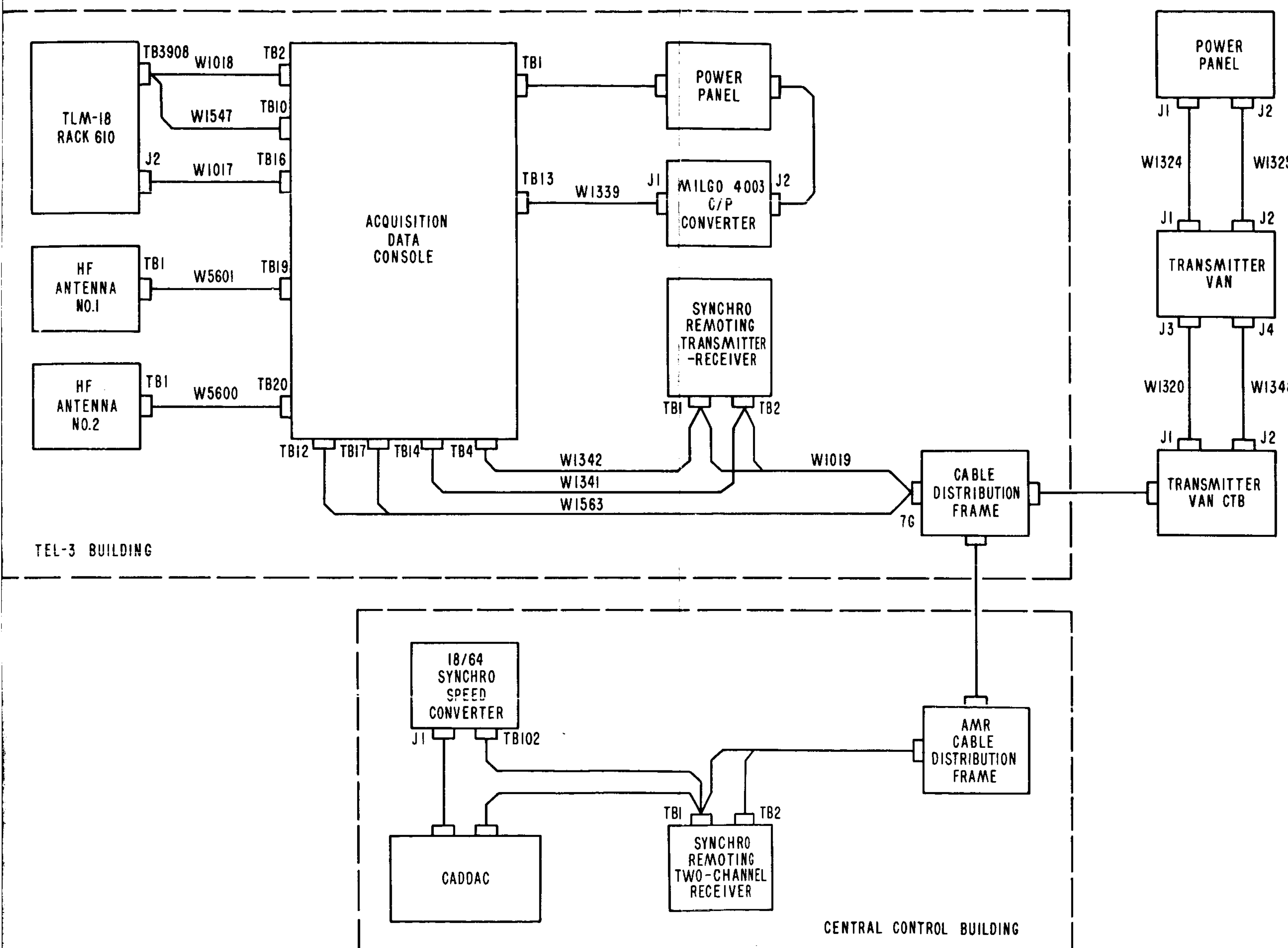


Figure 7-11. Acquisition System Interconnecting Cabling Diagram